Concrete

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The Future of Concrete

The Opinions of Far-Sighted Authorities Concerning the Probable Developments During the Next Few Years in the Various Branches of the Concrete Construction Industry—Presented as a Partial Guide to the Formation of Your Plans for the Years Just Ahead

CHANGES have been taking place rapidly in the concrete industry. New and improved methods have been crowding old methods into the discard.

As a result, concretors have found themselves continually faced with the need for adjusting themselves to these changing conditions. Those who do not or cannot make these adjustments are finding themselves deprived of their share in the growth of the industry. They see their more resourceful competitors carrying away the rewards.

Men in the concrete industry need to know more than simply what is the best practice today — they need to know also what will be the practice for tomorrow, so that they may shape their plans accordingly.

It is the purpose of this issue to help our readers anticipate these newer changes that will take place. We have, accordingly, devoted a large part of this issue to the consideration of the problems of the future. We feel that the information and opinions brought together here will be of distinct help to every concretor in shaping his activities in line with the probable course which the industry will take during the next few years.

You will no doubt recognize the names of the men who have contributed their opinions as leaders in their branches of the industry. They are men who look ahead fearlessly and they have welcomed the opportunity to serve the industry by assisting in building up the view of the future of the industry here presented.

Whether or not you agree in detail with all the statements made in this issue, you will find it worth while to give each statement careful consideration and to compare it with your experience and opinion regarding the future. Such material as this cannot, of course, supply those local and individual elements which each must appraise for himself. But it will, for those who will let it, supply an accurate guide to those general tendencies that will, in the long run, govern and control the forward movements in the industry.

Less Waste *Through*

—Overcoming Bad Construction Habits
—More Thorough Supervision
—Revised Building Codes
—Thriftier Design
—Higher Strengths
—Better Testing

By ARTHUR R. LORD
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I BELIEVE that it is reasonable to expect certain present trends to continue and to become much more prominent in the field of reinforced concrete design and construction in the near future. Economic considerations will outstay and outweigh even entrenched bad habits in the course of years and the trends which I mention below are all economically sound in my judgment.

Concrete will be mixed in completely equipped central mixing plants, doing away with the many thoroughly bad job plants now often found and superseding also even the best job plants except on work remote from large centers of construction.

Cements and aggregates will be tested and classified with regard to the properties of the concrete made from them. The prices at which various materials sell will bear a more logical relation to their intrinsic value than is now the case.

The numerous admixtures and treatments will be greatly reduced in numbers as the mystery that now surrounds them is dispelled by adequate tests made by unbiased agencies.

The Effect of Increased Supervision on Design

The very large savings in construction cost that may readily be realized at a comparatively small increase in engineering fees will be secured on a much larger percentage of the work built. Structures will be designed with more regard for the natural laws of mechanics that govern their behavior after erection, and also with much more consideration for the economic application of the many available materials and of the many possible alternate arrangements of members.

A more thorough supervision of concrete construction, especially in such matters as the complete control of the concrete placing and curing and of the steel placing, will lead to the use of a lower factor of ignorance in the case of engineers and contractors who are able and willing to assume the full responsibility for their work. I am aware of the danger of "favored treatment" on a political rather than on a merit basis, but I believe that proper safeguards can be established so that the ignorance and dishonesty of a few may not continue indefinitely to limit the accomplishments of the many.

Standard building codes, prepared by engineers of national reputation under the auspices of national technical societies, will be generally adopted by towns and cities throughout the country, doing away with the present illogical confusion of design and construction standards in various parts of the country.

We are learning every day that the first cost is often less and the final cost is always less when concrete work is handled throughout by competent engineers and contractors. There is, at present, a very great waste in the practical application of reinforced concrete.

More Economical Design

The amazing performances of concrete that has been grossly abused by both engineers and contractors is convincing evidence of the possibility of savings under adequate control of design and construction. I have faith to believe that this waste will be largely reduced within a few years as a result of the scientific, co-operative effort of engineers, manufacturers, contractors and others working through technical societies such as the American Concrete Institute and the American Society for Testing Materials and as a result also of well advised activity by trade associations.

I may be too optimistic, but it seems to me desirable and hence not impossible, that trade associations may come to realize that reinforced concrete, structural steel and timber are not properly competitive materials in most cases. Generally, in any given set of circumstances fully understood, the use of one or more of these materials is clearly indicated in preference to those not to be used. Engineers should use that material that best serves the purpose required. Most structures will be composite in character rather than exclusively concrete or steel or wood or brick. The proper competition is between building materials as a group and all those other necessities and luxuries that lay claim to a share of the nation's working capital.

Will a Fifth Ingredient Assure Durability?

By ALFRED H. WHITE
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To a greater extent than ever before, interest is centering on durability of concrete, and every influence that touches on this quality will be increasingly important.

Whether a better grade of concrete can be produced by adding another ingredient to the sand, stone, cement and water with which concrete is made, is a question that affects the future of the industry vitally.

No greater authority on this subject can be found than Professor Alfred H. White of the University of Michigan. For many years, the answers to this and to related subjects have been the object of his investigations. His opinions, based on the results of his years of research, are given in this article.

THE behavior of a well-made concrete can be predicted with reasonable accuracy and we know a good deal about the conditions which may cause its deterioration. The query is whether we may, by addition of a small amount of some material, produce a better grade of concrete than that which is made from standard materials—cement, water and graded durable aggregates. The final answer to any such question can only be made after the lapse of a number of years, but from our knowledge of the chemical reactions involved we may forecast how far the results of short time tests will permit us to prophesy the more remote future.

Finely Divided Aggregates

It is known that very finely divided sand and, to a greater extent, finely ground blast furnace slag and some other silicates react slowly with the hydrated lime which is liberated during the setting of portland cement, and do not merely play the role of inert aggregates. Additions of this sort should not show injurious effects which appear only after long periods of time. There are some colloidal mineral matters, notably clay and hydrated lime, which are sometimes added as lubricants. The hydrated lime which is near the surface of concrete changes to crystalline calcium carbonate with lapse of time and may be considered as a safe addition to the mixture. Clay remains as a colloid except as it may react with the hydrated lime liberated from the concrete. So long as it stays as clay it retains its colloidal property of expanding when wet and contracting when dry. It has sometimes been claimed that clay is a waterproofing agent, but it shrinks when it is dry and leaves capillary channels, through which water will travel. There is little reason to believe that clay will show harmful effects developing only after several years.

Water Repellent Materials

The water repellent materials which have been added for waterproofing purposes have been mainly mineral oils, vegetable oils, or soaps. These materials all retard the penetration of water into concrete by forming oily surfaces on the walls of the capillaries, which hinder the passage of water by capillarity. Mineral oils retain their mobility in the concrete and gradually work to the surface, forming stains. Vegetable or animal fats react with the hydrated lime to form insoluble soaps. The addition of a soap is preferable to the addition of a fat and most of the waterproofing agents which are now in use contain some form of soap. They may be added as soluble soaps, frequently ammonium soap, or as insoluble soaps mixed with some carrying material such as dry hydrated lime, or in the form of an emulsion. Small additions of soaps which become finely dispersed are sufficient to reduce the water absorption of concrete materially. Soaps resist oxidation and decay and may be considered as quite permanent additions to concrete. They must be used, however, with a full knowledge of the method in which they act. These colloidal materials tend to retard the rate of hardening of the concrete and the concrete must be kept wet continuously until it acquires a satisfactory strength. For the very reason that these materials are effective waterproofings it is difficult to wet the concrete after it has once become dry. Concrete which is waterproofed and which is allowed to become dry soon after it is made will never gain its full strength. If it is kept continuously wet until it has gained the required strength, it will suffer less than plain concrete from exposure to the weather.

Water Soluble Additions

The water soluble additions are made with two purposes in view. One is to lower the freezing point of the water and the other is to accelerate or change the reactions involved in the hardening of the concrete. The first purpose requires rather high concentrations of materials and the second demands only low concentrations. Common salt and calcium chloride are the two materials most commonly used to lower the freezing point of water. Common salt has been used for many years and good results have apparently been obtained with it in a number of cases. On the other hand, the use of high concentrations of any salt carries potential possibilities of harm. The process cannot be recommended unqualifiedly.

The addition of small quantities of soluble materials to affect the rate of setting of cement is recognized in the standard specification, which permits the addition of a limited amount of gypsum for this purpose. The admixture of small amounts of calcium chloride has found considerable favor in recent years, and other materials have been advocated. If we knew more definitely how these materials acted we would be able to give a better opinion of their effect after long periods of time. Portland cement on setting reacts with water and a surface film probably goes momentarily into solution. This solution is quickly precipitated, sometimes as a crystalline and sometimes as a colloidal material. The admixture soluble salt may change the rate of solution or change the rate of precipitation from solution. We do not know definitely which function is performed by any of these materials. Portland cement is a complex mixture of aluminates and silicates. In the normal hardening of a portland cement, the aluminates react first to form a crystalline material and the silicates react more slowly to form a material which is in part colloidal. The decrease in tensile strength noted with neat briquettes after a few months' storage is probably due to the internal stresses developed by the expanding silicates straining the bonds formed earlier by the aluminates. If the materials added accelerate the rate of reaction of one of these constituents of the cement and do not accelerate the others proportionately, it is possible that the course of the hardening process may be changed and that a different set of strains will be set up.

Herein lies the possibility of the advantageous use of these soluble materials. It is quite conceivable that a better relative rate of reaction of the constituents of the clinker might be obtained. It is equally conceivable that a less desirable relative rate of hardening might result. Definite results can only come after intelligent tests have been conducted over a good many years. If we knew more of the nature of the hardening process we would be able to forecast the value of these admixtures in a clearer manner. There is urgent need for much research in this field of the reactions which take place during the setting and hardening of cements, and of the effect of soluble admixtures upon these reactions.

Preparation for Floor Slab for Rubber Tiling

Concrete under-floors to be covered by rubber tiling should be finished true and even, and have a hard, steel-troweled surface which is proof against scaling, crumbling, or deterioration, according to a leaflet entitled "Standard Specifications Covering Installation of Rubber Floor Tiling," that has been issued by the Rubber Flooring Manufacturers Division of the Rubber Association of America, Inc.

A top mix of one part portland cement to two parts of clean, screened sand is also recommended. The floor, it continues, should be free from struck lines and in a clean, dry condition before any tile is laid. The scaly surface of frozen concrete should be removed and refinished with at least 1½ inches of new top coat.

To ascertain the presence of dampness in the sub-floor, it is recommended that one of several methods be used. One of these is the placing under a plate of glass at least twelve inches square sufficient calcium chloride to cover the space of the floor fairly well. The glass is then carefully sealed with putty and allowed to remain at least twenty-four hours. If dampness or capillary action is present the calcium chloride crystals will dissolve and disappear and water may collect on the glass and floor. If the slab is perfectly dry, the crystals will remain in their original form and no water will form.

One Standard for Cement?

By THADDEUS MERRIMAN
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THE engineer is gradually coming better to understand his portland cement. He is no longer satisfied to regard it as a dry powder delivered in 94-lb. bags and is keen for a more basic understanding of its characteristics than the simple fact that it meets the requirements of an arbitrary minimum specification. In other words, he is no longer content to accept such a specification as a definition of quality. The engineer is also learning that mere compliance with a minimum specification tends to push the better cement into the background and to overemphasize that which is not so good.

The time-honored theory of standardization on the basis of a single measure of quality has once more come to be recognized as basically unsound and incapable of meeting the requirements of the age. Under a single standard only stagnation is possible. In this situation the inevitable trend toward diversification of cement on the basis of its characteristics has set in. This trend will undoubtedly continue. More and more will the engineer come to think in terms of the hydration products which a cement develops as its set progresses. His interest will be concentrated on the character and the quality of these products and he will seek to use that cement the hydration products of which are best adapted to meet the requirements of his work. This demand will be readily met by the cement market of the future. In a general way it is being met even today.

Possible Future Developments with Respect to

Concrete Aggregate

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A discussion of the subject of better concrete is impossible without considering the part played by the aggregate used. Such matters as:

(1) Workability
(2) Uniformity
(3) Surface Durability
(4) Weight of Concrete
(5) Central Mixing Plant Development

All are largely problems in the choice, measurement and handling of aggregate.

The great importance of each of these subjects is recognized by every concretor. Any possible future development in this field will, therefore, vitally affect the contractor and engineer.

IN matters concrete the role of historian is difficult and that of prophet is impossible. The rate of progress in the art is such that history outruns prophecy. If, therefore, in attempting to prophesy, little more than a recital of well-established procedure is given, at least some of the fault must be ascribed to the virility of the youth who outgrows the garb before the tailor has finished it.

The future should be controlled by three main factors:

1. Recognized and evaluated evils that demand remedy. (Progress in technique.)

2. The clarification and evaluation of uncertainties. (Progress in research.)

3. The development of new demands and requirements, and of ways to satisfy them. (Expansion of the field.)

These three main divisions will be considered in order.

1. Recognized evils are:

(a) Stockpile variation in grading and in moisture content for aggregates that are assumed to be uniform.

(b) Lack of definite co-ordination between the physical tests and the concrete-making properties of the aggregate.

(c) Failure on the part of foremen, engineers, and architects to adjust correctly the mixture to the job. The best mixture for a particular piece of work is dependent upon construction methods and placing needs, as well as upon the ultimate use of the structure. The balancing of the opposing factors is too largely a matter of exercising judgment of a rare and discriminating sort.

The evils are and have been recognized. A campaign is and has been under way against them. The next five years should register much progress. The matter is largely one of control or technique. The central mixing plant is likely to contribute much toward their elimination. To play the part that it should, the central mixing plant of the future will need:

(a) Storage facilities for large amounts of aggregate in lots that have been screened into a sufficient number of sizes to make it possible to supply and maintain a uniform aggregate of predetermined grading. These facilities need to be such that moisture content of the aggregate can be known and controlled. This may be attained by keeping the aggregate either dry or by saturating it prior to use. In plants of this sort other methods of allowing for the moisture variation are likely to continue to be but moderately satisfactory.

(b) There is no indication that aggregates will become more uniform in nature. The wide divergence between gravels, slags, and crushed stones of many geological kinds is such that no mere sieve-analysis criterion can give more than a preliminary indication of the placing quality of the resulting concrete. The final adjustment of a mixture will necessarily be a matter of trial. The central plant should soon have at its disposal a systematic record of local aggregate performance such that it could speedily, economically, and uniformly produce concrete of the right workability and of established serviceability. The individual contractor or engineer has little opportunity for improving the quality of his mixture, no matter how willing or competent he may be. Variations in kind, grading, and moisture-content of aggregates are such that an ideal mixture, if found, could not be maintained. Because of these variations, knowledge from one job is only vaguely applicable to the next. Steel would not be the uniform product obtainable today if each individual contractor undertook to manufacture his own.

(c) From (a) and (b) it is apparent that the operation of the central mixing plant will have to be in the hands of an honest expert. He must be a man who can correctly evaluate his client's needs and who can aid him in his choice of mixtures. He may also assist in the placing by advice or otherwise. The central mixing plant may even supply placing equipment, by rent or otherwise, or it may include placement as part of its service. For remote work it could supply a quality of technical control, inspection and advice decidedly in advance of that now obtainable. The plant regularly engaged in the large-scale production of quality concrete for varied constructions would train its personnel in a way that cannot be approximated at present. It is this lack of adequate practical training facilities, upon the one hand, and of sufficiently intense specialization upon the other, that makes it so difficult for the engineer, architect, or inspector to know his own needs. Mixtures that are oversanded, undersanded, too harsh, too wet or too dry are daily insisted upon because the one in authority knows no better. Not every man's training is such as to enable him to detect a loose rivet or to pass upon the quality of the lumber in a standing tree. The schooling of the concrete technician has been a particularly unsystematic and haphazard process. Thanks to the educational programs of the Portland Cement Association and others, conditions are improving, but a great deal along this line remains for the future. And all problems of aggregates are problems of concrete.

2. The Clarification and Evaluation of Uncertainties. (Research.)

Notwithstanding the large amount of published matter on the subject of aggregates and gradings, there exists little systematic and co-ordinated evidence on the subject. While there is some difference of opinion on the subject of aggregate vs. strength, this may be termed a minor controversy so far as the usual mixtures, that is those with aggregates not exceeding two inches in size, are concerned.

As regards truly large aggregate (plums, etc.) the relative surface for contact with the mortar appears to be a real factor and it is not improbable that the specification of the future may require that a somewhat lower strength estimate be used for cyclopean concrete than for a similar mixture of smaller aggregate.

The importance of the grading and shape factor in present usual concretes is greater in regard to its effect upon workability, uniformity and water requirement than it is upon strength.

Further Knowledge of Aggregate

Among the mineral aggregates there are few that are not structurally adequate if located within the interior of a concrete mass. For surface exposure much remains to be learned of the kind of aggregate in its relation to deterioration of concrete by wear, weather, sea water, fire, etc. Moisture, temperature, and chemical effects are very important, and the future should see our knowledge advanced to the point that will make it possible to use finer discrimination in selecting aggregates for specific uses. For exposed ornamental concrete surfaces the varying coefficients of expansion of the aggregates and mortar matrix often tend to rupture the bond. Absorption with variable swelling has the same tendency.

Ornamental Concrete

The future should register much progress in the field of ornamental concrete. In this connection aggregate is of the utmost importance as regards both durability and appearance. Moreover, it remains for the future alone to tell whether artificial building stones have yet reached the point where they can be safely used for the surfaces of monumental structures and statuary without uncertainty regarding surface appearance after ten, twenty, or fifty years. Weathering tests that will adequately predict weathering performance are a need that the future must supply. The potential economies of concrete stone are such that man cannot wait one hundred years for the answer. The suitability of the best current artificial stones for all commercial structural purposes may be considered as established. It is only from the standpoint of time and appearance that more pertinent tests are needed.

The conventional tests for aggregates are none too closely linked to their usefulness in concrete. Wear or abrasion, toughness, sieve analysis, absorption, etc., all need to be evaluated more fully in regard to their bearing upon the properties of the concrete in which they are incorporated. Perhaps some method for estimating surface texture of an aggregate in regard to its effect upon the bond or adhesion may be developed.

3. Expansion of the Field.

For a material as widely used as concrete it is particularly difficult to see just what unoccupied fields are open to it, although there are no doubt many of them.

As light-weight aggregates are further developed, as they doubtless will be, concrete will become increasingly important for fireproofing structural steel construction and for floor and roof slabs. None of these uses are new or novel.

Just as cinders, slag, haydite, novaculate, chats, etc., are all illustrations of by-products used as aggregate, there will doubtless be much further development along these lines. This development is wholesome as long as the material is suitable and makes good concrete.

Admixtures to improve the grading of the aggregate may continue to be warranted in some instances, but the tendency will be to strip the admixture of any mythical cure-all garb and to weigh its value from the standpoint of comparative cost for the results obtained. Admixtures designed to do more than improve the grading are beyond the scope of this treatment.

Summary

To summarize: There will be an increasing recognition of the fact that the present problems of placing, uniformity, and control are largely problems in the choice, measurement, and handling of aggregate. Improved technique is the answer and it will be attained. The central mixing plant appears to be the most likely development to this end. Because of the importance which this procedure will probably assume, what may appear to be a disproportionate degree of emphasis has been accorded it. So far as the time element is concerned the plastic state of the concrete is of sufficient duration to permit of rather long hauls. Leakage and segregation enroute must be avoided. Tight trucks that continue the mixing process while on the road are already in use in some places.

More must be learned of aggregate in their relation to the surface durability of concrete. Tests which are better and more directly applicable must be devised for aggregates if their suitability for use in concrete is to be accurately prejudged.

Since the unit weight of concrete is greatly influenced by that of its aggregate, it follows that progress in reducing the dead weight of concrete construction necessitates progress in the further development and use of light-weight aggregates. No doubt there will be further progress in the use of appropriate by-products as aggregate.

As stated in the beginning, the role of prophet is hardly separable from that of historian in the case of things pertaining to concrete. Whatever the course of the future may be, the writer predicts that it will loom large in comparison with the past and that these feeble attempts at a forecast will be small and inadequate when viewed in retrospect.

Coming Convention

Concrete Reinforcing Steel Institute—April 15th to 17th. Fifth annual meeting, at the Kenilworth Inn, Asheville, North Carolina.

What's Coming Next *in the* Concrete Products Industry?

By "SPEC" COLLINS

Who Needs No Introduction

THE things I'm putting down on paper today about the concrete products business of tomorrow are not alone my own personal views, but the views of leaders of the industry from all over the United States and Canada, culled from innumerable conversations during the recent conventions of the National Concrete Products Association and the American Concrete Institute at Detroit.

Let's say in the first place that the next five years are going to be years of aggressive selling. The concrete products industry is going to bring into its organizations many men totally without knowledge of the industry itself, but well versed in the knowledge of salesmanship. It is going to train them as no other concrete products salesmen have been trained before. It is going to furnish them with data and information that the average concrete products salesman of today thinks is superficial and unnecessary. These men who will already be trained salesmen when they enter this business will be responsible more than any other one factor to an increase in this business so that in five years it will be doing double the volume that it has at any time during the past five years. Five years from today there will be no less than two thousand salesmen devoting practically all of their time to the sale of concrete products. Another change that will come about in selling will be the development of brokers in the business who will contract for and sell the output of many of the larger plants and chains of plants. The next five years will see concrete products manufacturers as members of their national association national advertisers in many of the popular magazines and newspapers. More money will be spent by national advertisers of concrete products in this period than in the past fifteen years. This will result in a breaking down of prejudice and pave the way for the master salesmen spoken of earlier in this paragraph.

The Next Five Years Will Bring to the Concrete Products Industry—

1. More salesmen and more advertising.
2. More co-operative effort between manufacturers.
3. Fewer plants but larger ones.
4. More industrial buildings and more homes of concrete masonry.
5. High speed production in products plants.
6. Higher grade, lighter weight units.
7. Developments of many new lightweight aggregates.
8. Greater diversification of concrete products manufactured and sold.
9. Many mergers and consolidations into large ownerships with the aid of outside capital. Development of the "chain plant" idea.

I just want to emphasize the foregoing paragraph in hopes that it will be more helpful. Unless the products man who is in business today sets his house in order and makes a product that is easily salable and unless he hires the right sort of men to sell this product he is going to be in a bad way five years from now. He's just got to get out and sell his stuff during the next few years, not in competition with other manufacturers of the same material, but in competition with manufacturers of competitive materials used for the same purpose. There has been too great a tendency for concrete products men to fight among themselves the past few years. I believe that they now realize that this has gained them nothing and I look forward to a period of greater co-operative effort.

Right now there are too many concrete products plants in the United States. Five years from now there will still be too many plants, but there will be only about half the plants there are today. In place of the many small plants that we now find in all the larger producing centers we will find the business concentrated in four or five large plants that are strategically located for delivery purposes. This weeding out will come in two ways, consolidations and mergers and a gradual survival of the fittest. The "chain plant" will be a logical development of this, with much outside capital brought into the industry to finance and sustain these chains.

Plant design will not change materially in the next five years. The basic principle of a straight flow of materials through the plant will be continued. This flow will be speeded up, however, and greater productions take the place of the only partial efficiency present in most plants today.

Multiple Shift Operation?

Much has been said in concrete products meetings the past few months about the advisability of running multiple shifts as a means of speeding up production and cutting down fixed overhead per unit of production. I believe that five years from today most of the large producers will sit back and laugh at the arguments they used against this method of more efficient manufacturing. I've probably spent more time and thought on this part of the future than any other and in spite of the many arguments against it today I believe that it is bound to come. It will come in a modified form at first, but as sure as there are concrete products produced in this country the more efficient plants will be running two or more shifts during the high production and sale periods. This method of production will start in the East and gradually be taken up by the plants in the Middle West and West.

In most plants today practically all men are paid on an hourly basis regardless of production. Five years from now nearly every man in the bigger plants from the mixer men to the yard men will be paid on a piece work basis. This will not only serve to speed up production but will reduce unit costs. New machines of the automatic type will be developed in the next five years that will make obsolete those in current use today. Semi-automatic machines will remain virtually the same in principle but will be equipped with many refinements that will to all practical purposes make them automatic machines with a higher productive capacity than most so-called automatic machines on the market today.

Perhaps one of the most outstanding developments in manufacturing in these years to come will be in improved curing methods. High pressure steam is being experimented with at present and this with other methods will make it possible in the next five years to manufacture a product that will meet all present building code requirements on the day it is manufactured. This will result in an almost steady flow of material through the plant and into the yard with little time lost in curing or other manufacturing processes. Special cements, at a price low enough for economical manufacturing, will without a doubt play a part in this transformation of manufacturing methods.

Specialties

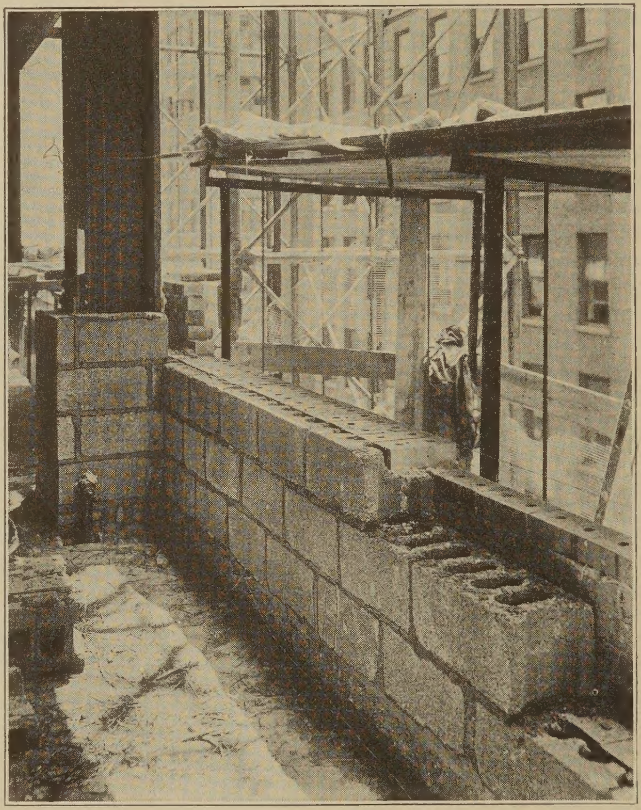
Concrete products plants will not be relying alone on one type of unit to carry them through the entire year. The next few years will see a decided development of specialties. Most of these will be of concrete. Some will be of a different type but sufficiently allied with the concrete products industry to permit easy selling. They will serve as a means of reducing fixed overhead and taking up slack during dull seasons.

Continued development in the use of concrete building units for above grade construction will be an outstanding feature of the next few years. Not only will an unusually large number of units be used in backup construction, but the development of homes and industrial buildings with walls of concrete masonry and covered with stucco will be far greater than ever anticipated. In the East large industrial housing projects will be built exclusively of concrete masonry. This development will also take place in the South and West. The most dominant group of concrete masonry buildings in the Middle West will be constructed at the Chicago World's Fair and will receive advertising that will do much to strengthen the concrete products manufacturers' market.

Will the Shape of the Unit Change?

We may expect to see some changes in the shapes of the units in common usage at the end of the next five year period. Units will be lighter in weight and finer in texture. There will be a great development in the light-weight aggregate field. With four or five light-weight aggregates in the field the market for concrete building units of these materials has naturally been hampered to some extent. But at the end of five years we will see eighteen or twenty such aggregates in common usage and the resultant product either specified or alternately specified with some competitive product in every worth while job in the United States. This development in the light-weight aggregate field has already done much to speed up the concrete building unit business in the large centers of production. With a number of new light-weight aggregates on the market and available to the smaller producing centers at a reasonable price there will be many more farm and rural buildings of concrete masonry constructed than at the present. This will open a market, the magnitude of which is little realized by most concrete products manufacturers.

I have every confidence that the next five years will be years of tremendous expansion and development in the concrete products business. In fact, the development will be so swift and of such magnitude that it will eliminate many manufacturers who are not foresighted enough to sense this future and who cannot keep pace with its many changes. We have passed through the pioneering state. We have made our mistakes. We have conquered many of the time-worn prejudices against our material. We now stand on the threshold of a new era of merchandising and manufacturing. The reward of the pioneering years of the past will go to the aggressive and open-minded manufacturer who will accept the swift pace set for him by the kaleidoscopic changes of industry and will forget the limitations and traditions of the past in maintaining this pace.



An example of the large future market for concrete block. The use of cinder concrete block for backup in filler walls in the 25-story Integrity Trust Building in Philadelphia gives a hint where the greatest volume of sales may be looked for in the future

Read also the report of the recent meeting of the National Concrete Products Association, published on page 56. A definite program of future activities that will be of value to every products manufacturer, was planned.

Building Ahead of Traffic

By R. W. CRUM
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Gigantic as the pavement construction industry has become, it is still lagging far behind present needs.

Some means of catching up must be found and put into effect. The design of concrete pavements and the methods used to build them must be geared to this new need. Design and construction methods must, during the next five years, catch up with the technical knowledge already available.

What these new developments will be, is pointed out by R. W. Crum. His suggestions and warnings will help every highway engineer and contractor.

IN spite of the great advance in the art of highway building since the advent of the motor vehicle forced the adoption of entirely new ideas and methods in providing for highway transportation, the constantly accelerating growth of traffic has kept ahead of the development of highways. Traffic is congested, delayed and subject to hazards and everywhere there is insufficient mileage of improved roads. The principal reasons for the unsatisfactory conditions have been the physical and financial impossibility of keeping up with the growth of highway transportation, but many constrictions, narrow bridges, sharp turns, congested intersections, etc., exist because of lack of realization that the sole function of the highway is to serve traffic.

The traffic congestion in and near the large centers of population is rapidly becoming worse instead of better. Most remedial measures so far used are outgrown almost before they are put into effect. It is beginning to be realized that highway transportation can only be freed from restrictions and undue hazards through the construction of highways designed for the expediting of traffic. The general effect of most regulations is to impede the free flow of traffic. However, such restriction must be born in the interests of safety until the hazards can be removed. Wacker Drive in Chicago, the super highways leading from Detroit, the new Westchester County parkways near New York, and reconstruction on the Boston Post Road between New York and Boston are examples of what is needed in the metropolitan areas.

Many extensive projects for the relief of traffic congestion in the metropolitan centers will have their inception in the next five years, and will be making their influence felt toward the end of that period, although it will take a much longer period than five years for road building to catch up with and draw ahead of traffic.

In this discussion we are more concerned with the future of concrete pavements. In general the next five years will be a period in which design and construction practices will catch up with the technical knowledge now available, as well as one in which research will approach the answers to many important problems.

Design

In the design of the highway as a whole, more attention will be given to features for providing safety and expediting traffic. Auxiliary structures must not be allowed to cause constrictions, even though when the road is built traffic may be light. This is especially so in the case of rigid slab pavements, which cannot be cheaply modified to meet changing conditions. Such items as degree of curvature, super-elevation on curves, location of intakes and other drainage structures, location through or past congested areas, alignment and width of bridges, and width and type of shoulders are some of the items to be considered in this connection.

Design of Slab

The broad principles upon which the design of concrete paving slabs depend are now well known and have been adopted by a majority of rural highway builders. There are, however, several moot points which should be settled within the next five years upon the basis of factual investigation.

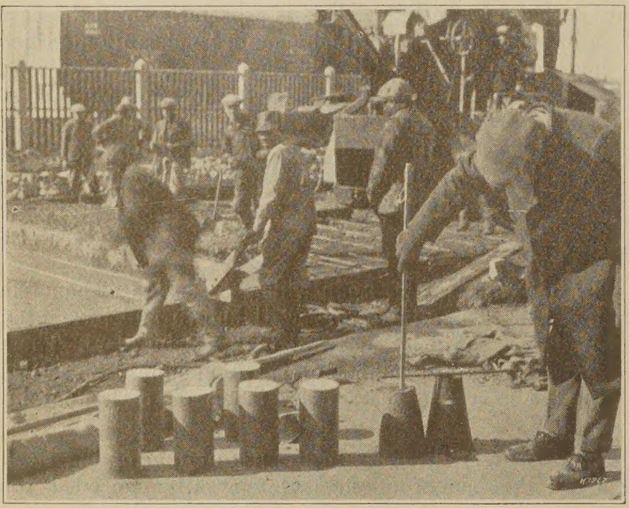
There is great diversity in the use of reinforcing steel, although the benefit of steel is generally conceded for most conditions. As soon as research and theoretical study define what the function of the steel should be, the designer can no doubt compute the proper location and amount for given conditions.

A fact-finding survey is needed to define the conditions which should govern the use of expansion joints, and the types best suited for various conditions. The present trend appears to be toward their use, although more information is needed as to methods for determining spacing. Similar information is also needed for the proper use of contraction joints to control irregular cracking.

Very intensive research is being devoted to the relationship between road surface and underlying soil. As respects concrete pavements the effect of soil upon the durability of the slab has not yet been defined. Undoubtedly within the next five years this matter will be well understood, and those highway engineers who lead in the adoption of improvements will be designing paving slabs to meet the variations in subgrade conditions.

Control of Concrete

Within the last ten years the factors that control the quality of concrete have become well understood, and methods for the production of strong, durable and uniform concrete are coming into general use. Within the next five years refinements in the control of concrete will be generally adopted that would have been deemed impossible just a few years ago. These methods have been proven practical and their use is growing rapidly. Control of concrete may be divided into: design and mixture, measuring materials, and mixing. In the design of mixtures, or proportioning, the significance of the water-cement ratio is generally accepted in theory, and provisions based thereon are incorporated in many highway specifications. As yet the most common use is merely a limitation on the amount of water allowable. In a few cases the water-cement ratio method of proportioning together with careful control of aggregate grading is being used to provide mixtures of maximum economy. Some practical use is being made of the mortar-void methods of Dr. Talbot in designing mixtures for specific cases. It is to be expected that within the next five years there will be a great increase in the number of jobs for which the mixes are designed for maximum economy with the materials available. Also in those regions where economy requires the use of a maximum quantity of coarse aggregate, the practice of dividing the coarse aggregate into several sizes will become common. In the case of pavement work where materials form such a large proportion of the cost, good practice will require that the mixtures be designed to give concrete of the desired uniform strength at least cost, and that the quantities of materials to be used on the job be accurately predetermined. Sound methods for doing so are now available.


Quality control of pavement concrete has demonstrated its value, both from the standpoint of quality and economy. Its use is sure to be extended in the years just before us

Measuring Aggregate

It is also rapidly becoming generally realized that the benefits of scientific proportioning will not accrue unless means are taken to insure that every batch has the composition expected. Accordingly, measurement of aggregates by weight making allowance (by test) for the moisture content is being very generally adopted on highway work, and the end of the five year period should see the old fashioned volumetric fixed proportions become nearly obsolete. Measurement of sand by inundation will no doubt greatly increase on some kinds of work. The greatest benefits from scientific methods for proportioning, and accurate measuring cannot be realized as yet for lack of the solution of three problems. (1) Methods for accurate measurement of water under all conditions are not available, (2) there is no method by which workability of concrete can be defined and tested, and (3) the fundamental factors upon which the design of concrete mixers should be based have not been determined. It is probable that devices that will permit accurate water measurement under the trying conditions that surround the moving paving mixer will soon be available, and in common use. As to workability tests, the problem has not been solved, but with the number of research men who are interested, the solution may arrive at any time. In the case of concrete mixers there are many factors beside those of speed and length of mix that affect the quality of output. Thorough understanding of the principles involved will require exhaustive research, which on account of its costly nature may be slow in proceeding. It is to be hoped that arrangements can be made for extending the line of work which was recently reported by Dr. A. N. Talbot at the annual meeting of the Highway Research Board.

Construction

There will, of course, be many developments in the mechanical methods of laying concrete pavement in the next five years, for the constructors will continue to strive for lower cost of operation. The last five years have seen the season's output of a concrete paving crew almost doubled. Methods which will increase the density of the concrete as laid, and which will enable the mixtures containing large amounts of large size coarse aggregate to be more easily worked into place with a minimum of water content will no doubt be further developed.

Prevention of Scaling

The scaling of concrete surfaces is a phenomenon for which preventive measures should soon be established. Scale is the result of many diverse conditions, but it seems apparent that a co-ordinated study throughout the country might establish the facts upon which proper treatment could be based. It is hoped that some organization will undertake such a study.

Curing

Progress is being made rapidly in the evaluation of the different methods for curing slabs. The U. S. Bureau of Public Roads and several state highway departments are conducting intensive experimental studies, and the Highway Research Board has under way a special project for the correlation and study of research information and for the co-ordination of the experimental work in the various states. Within the next five years practice in curing should be stabilized upon the basis of an understanding of what we are trying to accomplish in curing.

Maintenance

A chief problem of the maintenance engineers is the protection of cracks and joints to prevent progressive deterioration. There is wide diversity of practice and opinion, and a nation-wide research project into this problem is urgently needed.

In reading over this article it may appear that not very much outstanding progress is definitely predicted for the next five-year period. This is because the more obvious and spectacular improvements have already been made. There remain the no less important, but more intricate and complicated problems, which require careful thought and intensive research. In this stage progress is bound to appear more slow. To offset this, however, real research work is now being done on a greater scale than ever before.

Cinderella

—a True Fairy Tale that Is Also a Prophecy

By DR. F. S. ONDERDONK
University of Michigan, Ann Arbor, Mich.,
Author "The Ferro-Concrete Style"

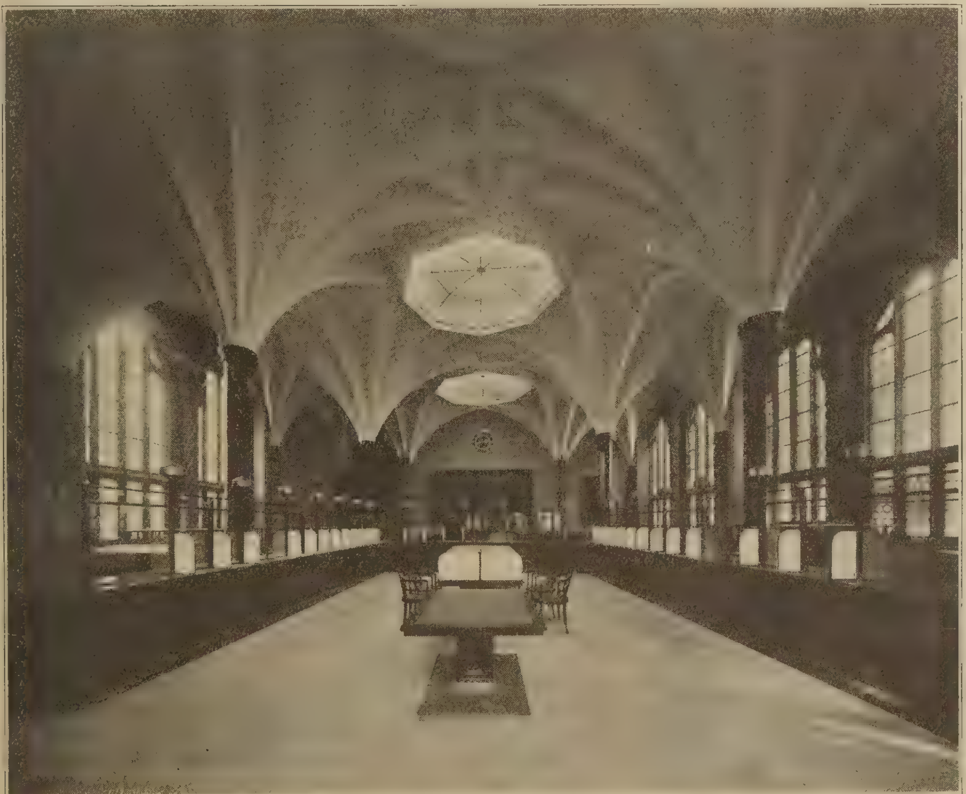
RECENTLY a prominent Detroit architect, addressing architectural students, pointed out the new materials which are bringing about a new style. Steel, new types of tile and other materials were mentioned—only concrete was forgotten. This omission is typical of the role ferro-concrete plays in the studios of many American architects: That of Cinderella—a useful but despised helper. The above speaker deplored that the aesthetic possibilities of unclothed steel had not been utilized on this continent "as if nude steel were indecent." Reinforced concrete's fate is still worse—it not only can not be displayed—it is classed with the unmentionables!

It is exasperating to see how ferro-concrete—the building material which surpasses all others by the number of its possibilities of construction, formability, surface-decoration, as well as by its unity and inherent elegance, is carefully hidden behind small units of stone, clay or terra cotta by most architects in the United States, California excepted.

But happily Part II of Cinderella's story is being enacted in Europe, which is first: The leading architects abroad recognize the aesthetic possibilities of ferro-concrete and a new style is developing. Architectural princes such as the Brothers Perret, Mendelsohn, Professor Dominikus Bohm, Le Corbusier, Medgyaszay and others have been fascinated by Cinderella's truthfulness and beauty and have become her devotees.

A new style may result from the introduction of a new religious spirit; or it may blossom forth when a new material brings new possibilities. Reinforced concrete has practically unlimited possibilities with regard to extension and strength in addition to those mentioned above and we can therefore consider it the most perfect building material in existence. We must appreciate the opportunity of living in this period when we can watch and take part in the development of a ferro-concrete style.

Many so-called characteristics of concrete architecture apply to the traditional method of wood-centering and not to concrete itself. The increased use of curved metal molds, self-centering reinforcement and of the cement gun will allow the innate qualities of reinforced concrete to come into play, especially as regards plasticity and



Interior of the Municipal Savings bank at Freiburg i. Br., Germany, showing the intricately vaulted ceiling adaptability to every form, size and curvature. Wood-shuttering signifies "stammering," i. e., building every part twice, first as mold and then in concrete. Neither is done with that care and patience used in building with materials where the constructing is done for good (as in the case of wood or stone).

That the builder's love of beauty can master even the limitations of wooden molds is shown by the complex vaulting in the Freiburg Savings Bank. Very thin wooden planks are sufficiently bendable as to permit the casting of these graceful shapes.

Third Dimension Conquered

Reinforced concrete has conquered the third dimension: former styles of architecture have been characterized by an adherence to the vertical: stone was laid upon stone, brick upon brick. Projecting cornices and balconies were like daring features in an acrobat's display. The unity of ferro-concrete construction makes projection on a much larger scale a natural, commonplace matter. For the first time the architect is fully master of space. He has unlimited possibilities in designing the outline of his building; as the Baroque architect curved and cut in the design of his floor plan, so the concrete architect will be able to abolish the straight contour in his section and elevation.

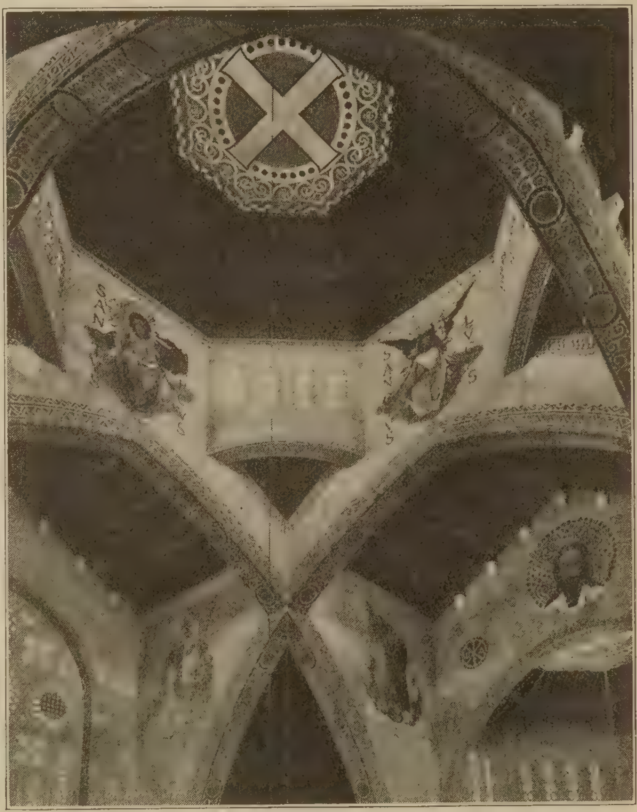
It is just this wealth of possibilities that endangers the creation of a specific concrete architecture. The weaknesses and limitations of a material have been essential in developing its style; it is by overcoming obstacles that a builder wins our admiration. Concrete's vast opportunities are as tempting as newly acquired riches. No other mode of construction so tests the architect's abilities, and some architectural freaks which have been committed with ferro-concrete in Europe remind of the manners of a parvenu.

Restaurant "Die Bastei." A ferro-concrete structure built on an old fortress tower overlooking the Rhine, at Cologne, Germany

Ferro-concrete, consisting of "liquid stone" and bendable steel rods, can easily adapt any conceivable form. As J. Earley pointed out, sculptoring concrete is much more economical than cutting natural stone.

Concrete "Lace"

In our modern world we have no time to look at small ornaments and decorations as we hurry past a building. Large spaces of even surface, set off by outstanding features, alone can stand the test of the automobilist who flashes by or the business man who sends up a glance. The development of a new type of concrete tracery is the solution of this problem and we can expect it to become one of the main characteristics of a ferro-concrete style. Perrets' churches in Le Raincy and Montmagny (CONCRETE, December, 1927) show concrete tracery in their most primitive form—simple geometric shapes in various combinations.



Polygonal lantern over the crossing in St. Louis church, Vincennes

Every desired design and scene can be created by the silhouette effect of the reinforced concrete backed by the curvilinear window-holes—giving by day a dark and at night a lit-up background to these stone-silhouettes which will be very monumental as they need no bas-relief. The facade's concrete framework of piers and girders will become veritable frames for pictures and ornaments wrought in concrete tracery. The Gothic tracery served to strengthen the window-panes; but concrete tracery will not have a function distinct from that of the bearing members: the reinforcement will tie concrete tracery and columns into *one,* will make the entire wall a rigid unit pierced by holes. The traditional ornaments and sculptured decoration cast too pale shadows as that they could attract the attention of "the man in the street."

(Continued on page 42)

New Models *in* Block

By EDGAR D. OTTO
Concrete Products Manufacturer,
Downers Grove, Illinois

Every industry changes from time to time. Sometimes these changes are fundamental; sometimes they affect only some of the details.

It is reasonable to expect that there will be changes in the concrete block industry during the years immediately ahead. But what will they be? Will the current sizes and shapes remain? Will light-weight aggregates make the use of larger units practical? Will new types of aggregates appear? What of manufacturing developments?

These are some of the questions asked and answered in this article.

THE future of the concrete products industry is full of promise, provided the manufacture of concrete masonry units is intelligently conceived to keep pace with developments in the construction industry; and provided further that such products are properly merchandised.

It is my opinion that the current sizes and shapes used for bearing wall construction are adequate and do not call for material change in size or shape.

One of the factors which has helped to restrict the sale of concrete products in the past has been the fact that such products were primarily conceived of as bearing wall units. Since bearing walls constitute only a percentage of masonry construction and exclude the very large field of partition or enclosure units and hollow floor units, it follows that only a portion of the potential market has been appealed to.

As regards the non-bearing wall field, it is by no means certain that the present sizes and shapes will prove satisfactory over a stretch of years.

Effect of Light-Weight Aggregates on Field

The foregoing statement has in mind the thought that, since strength and load-carrying ability are not primarily the physical characteristics desired, the opportunity exists for the use of materials considerably lighter in weight and possessing characteristics which differentiate them from sand and gravel, crushed stone, and heavy aggregates, which heretofore have been chiefly used in the manufacture of concrete products.

The development of light-weight aggregate of various types would seem to open up a field for the employment of concrete units which is very much greater in extent than has been open to the units made of heavier aggregates. It is entirely possible that units of larger sizes and shapes will be worked out for specific uses. For example: It is readily conceivable that light-weight aggregate may be made in sheet form for room enclosure work, so that a section from floor to ceiling can be covered with a single unit. This is only one of many such illustrations which might be given.

Further than this, the outstanding fact is that we are just beginning to get inquisitive as to the use of chemical reagents in connection with the use of cement. Heretofore it has been considered sufficient to regard portland cement as a complete element and to concentrate upon mechanical methods of combining it with aggregate to produce a given result. The indications are that the application of colloidal chemistry to the cement field and the introduction into the mix of certain chemicals, will produce concrete on an entirely different basis than has been the case heretofore. We shall, therefore, find that concrete of very much quicker setting and hardening properties will result; that chemical reagents will be found which will enter into active chemical combination with the materials composing the bulk of the concrete mixture. Therefore, it is fair to believe that advantage will be taken of the acceleration of setting and hardening time and the chemical bonding of elements in the concrete mix so as to bring about profound alteration in the character of equipment used for the production of concrete products, and in the form and size of the machine-made products as well, and this more particularly in the non-load-carrying field.

The construction industry is quick to seize upon new materials or new shapes which make possible more economical production, and to the extent that concrete products can continue to point a way to construction economies, there will be an ever increasing use of such products.

These observations are of particular importance because of the fact that the manufacture of concrete products is essentially a local industry, and the great degree to which utilization can be made of local materials gives a corresponding advantage in terms of delivered cost of such product in competition with other products shipped in from a distance.

There is a very much larger volume of readily accessible and available local raw materials suitable for use in the manufacture of concrete products than is the case with the competing materials, gypsum and clay. Therefore, by more intelligent adaptation of the sizes and shapes of product to the working out of economies in construction and by proper design of product, both as regards components of the concrete mixture and the form and shape of the product, the chief talking points of competitive materials from any physical standpoint can be duplicated and surpassed.

Likewise, if full advantage is to be taken of the developments discussed above, it is obvious that the industry must be prepared to manufacture such units on an increasingly larger scale. The local manufacturing plant must be equipped to manufacture in substantial volume before it can hope to receive such character of business; therefore, it would seem to follow that the most marked change in the industry is going to be along the lines of the development of larger unit production plants, equipped to make a wider range of products and to carry larger stocks than has been the general custom in this industry, enabling them to compete with the manufacturers or distributors of clay and masonry products in terms of stocks for spot delivery, ability to service their product, etc.

The increased capacity of plants will necessarily bring in its train lower manufacturing costs, so that in the large centers of population it would appear that the small plant would find it difficult to compete with the larger plant. The trend of the industry, therefore, in the larger centers of population, would seem logically to be in the direction of fewer and larger manufacturing units. This apparently is what is occurring in other lines of the industry.

While it is impossible to predict what the specific characteristics of the concrete industry will be a stretch of years ahead, it is possible to survey the future in the light of the past, take cognizance of present conditions, and discover general trends of a more or less defined character. It is these trends that I have attempted to indicate in the foregoing discussion.

Tomorrow's Concrete Job

Composite Structures—Light-Weight Aggregate—Higher Concrete Stresses—New Types of Contractors' Equipment—Increasing Volume of Concrete Construction

By JOHN G. AHLERS
Barney-Ahlers Construction Co., New York

THE future for reinforced concrete and plain concrete construction has never been brighter than it is today. We are about to reap the fruit of the years of development, that have made concrete a product of known quality and certain in performance.

As I see it, there will be more and more a tendency to use concrete as a composite part of structures. By this I mean that concrete is becoming adaptable for such things as units of construction, as substitution for heavier and extensive parts more so than it has been in the past.

Light-Weight Aggregate

As such, the use of light-weight aggregate is going to make concrete very attractive in connection with high structures where dead weight is of great importance. The use of such an aggregate instead of an uncertain quality of cinders or other aggregates, will make concrete a very suitable product for extremely high structures where steel structural members can be used for the supporting and main connecting parts. A light type of concrete flooring system will assist in making a building more economical.

I see in the future a revision of building codes permitting the use of concrete with a factor of safety that is reasonable, where now this structural material is used with factors of safety that are so great as to be unreasonable. This means greater economy and, therefore a stimulus to the construction industry as a whole.

I see an increased knowledge about the manufacture and use of concrete among all engineers and people in connection with the construction industry.

We will see the use of higher stress in reinforced concrete and we will take advantage of our knowledge how to manufacture good concrete and so design the structures that every pound of strength in the concrete is used.

Contractor's Equipment

There is still an opportunity for the development of better machinery, more efficient equipment and apparatus more certain in its functioning. I predict the making of equipment that will give plastic workability and strength in concrete, perhaps by using the effect produced by so called prehydration, by considering time of mixing and better proportioning of aggregates.

With all these forward steps in the concrete industry will go hand in hand the inclination of both federal and state departments to take advantage of this progress and encourage the use of concrete in connection with the large projects that are certain to go forward during Mr. Hoover's administration. We will have at the head of the country an engineer who will know the tremendous economic advantage of using the funds and construction volume of the state and federal authorities as a balance-wheel in the prosperity of the country. We can feel sure that this construction, when released, will take full advantage of the use of concrete and reinforced concrete.

Haydite Manufacturers Form Own Association

The interests at present manufacturing Haydite, light-weight concrete aggregate for use in structural concrete and concrete products, met February 4th at the Bismarck hotel, Chicago, Illinois, and formed a permanent organization known as the Haydite Manufacturers Association.

The purpose of the association is to advertise its material, conduct research work, promote general distribution and the use of Haydite, and in general function similarly to other trade associations.

The officers of the association for the ensuing year are B. W. Ballou, president (president, Haydite Co., Kansas City, Mo.); F. W. Butterworth, vice-president (general manager, Western Brick Company, Danville, Illinois); Dan F. Servey, secretary-treasurer (vice-president, Haydite Co., Kansas City, Mo.). The general offices of the association are at 403 Mutual Building, Kansas City, Mo.

Membership in the association is limited to manufacturers of Haydite and is made up at the present time of the following companies, who operate a total of eight plants, having a capacity of about 600,000 cubic yards per year: Hydraulic-Press Brick Company, St. Louis, Mo., and Cleveland, Ohio; Western Brick Company, Danville, Illinois; J. H. Black Company, Buffalo, New York; Cooksville Company, Ltd., Toronto and Montreal, Canada, and Haydite Company, Kansas City, Mo., and Pittsburgh, Pa.

Design Possibilities *vs.* Present Actualities

By JAMES R. GRIFFITH
Author of articles, "Reinforced Concrete Design Simplified," being published in CONCRETE
Assistant Professor of Civil Engineering,
Armour Institute of Technology
Chicago, Illinois

THE prophets of biblical times are said to have received divine inspiration. Yet Sir Thomas More foretold more achievements than any of his biblical predecessors. His wild visions of yesterday are facts of today. The prophets of yesterday, while leaving their monumental visions, failed to give their recipe for inspiration. When the editor asked me to write on the future of design, I requested the visionary formula as I was in some doubt as to my own ability. Chicago "hooch" was suggested as all powerful but vetoed. So I will have to depend upon smoke blown at the desk lamp for inspiration. Perhaps through the haze of smoke, concrete visions will take form.

Will future design theories include the tensile resistance of concrete?

Will economy of space and transportation demand a concrete of higher elastic limit?

Must there be a future trade, highly skilled, to place concrete?

Will batch mixing be abolished in favor of continuous mixing?

Will testing engineers sample the materials during the mix and determine, at once, the ultimate product?

Will the stress analysis of the future be made from a model?

There are differences of opinions on these questions, of course. Prof. Griffith gives his opinion in the following article. Whether you agree or disagree with him on these points, you will agree with his conclusion that "consistent accuracy will be the keynote of future design."

First let me define the designer as one who applies theories of today to contingencies of tomorrow. Future design will be controlled by the knowledge of those two fundamentals. Theories of today, possibly void tomorrow, are the result of research. Contingencies of tomorrow offer a fertile field for conjecture. Factor of safety has been defined as a "factor of ignorance." When theories become certified facts and contingencies take assured form, there will be no need for a factor of ignorance.

I believe that very little is now known concerning the action of concrete in combination with steel. Worse yet, we do not apply what we do know to be a fact. Many specifications require cement briquettes to show a tensile strength of at least 200 lbs. per sq. in. at the end of seven days curing. Very true; briquettes of sand and cement are different from the concrete as poured in the field. But think of the miles of concrete highways being poured every year. In the majority of these highways, the tensile strength of the concrete is used as a basis of design. Yet in the development of the design formulas applicable to structural members, our first assumption is "in calculating the moment of resistance of reinforced concrete beams and slabs, the tensile resistance of the concrete is neglected." It is a safe assumption, but is it consistent? At least it is not economical. Future design theories will include the tensile resistance of the concrete. As labor and material costs increase, economy will demand such changes.

As manufacturing standards have improved, allowable stresses have increased. One of the objections to concrete is the excessive sized members which necessarily take up too much room. Incidentally, the transportation costs on all of this material is appreciable. There have been steel structures in the past in which the saving of transportation charges have warranted the increased cost of higher stress material. So in the future, economy of space and transportation will demand a concrete of higher elastic limit.

Many criticisms of reinforced concrete, justly made, can be attributed to human ignorance. The designer, the specification writer, and the workman, all fall into this category. Let me cite a few examples that have come to my attention, although any construction engineer could write a book on the subject. In the first place, the inspector is placed on a job to catch mistakes. Yet he is usually the least experienced due to the remuneration. The superintendent of construction on one Chicago school building was a young, inexperienced student taking it as a summer job. He was training for the priesthood. I was superintendent on a half-million dollar job with twenty-three different contractors to look after, and was, in addition, expected to do all the inspecting. It would, however, require one inspector for each workman to catch every mistake under the present status of construction. When the forms were taken off one column, 2 in. of sawdust and shavings were found at the floor level. I know of several high massive columns which are 4 in. out of plumb. In taking over one job where the foundation walls had been poured, I found one spot where the concrete could be dug out with a stick. The anchorage hooks on some massive reinforcing bars interfered with a steel column base. The hooks were cut off. The plans called for a total number of bars in a column footing. The workmen tried to lay them all in the same direction. A definite mix but no provision for accurately measuring the batch materials, was specified. Bar positions are specified, but no provision made for holding them in place during pouring. And so on indefinitely. Is it any wonder that other building material interests have knocked concrete in trying to extol their own virtues? But a knock is a compliment. We knock only that which we fear. Criticism, even of the knocking variety, should always be seriously considered. Only by criticism can we improve. I once worked for a man who, by his own statement, never made a mistake. He is still in the same capacity after nine years. The human element, or shall I say human ignorance, is the weakest link in the present chain. It has compelled designers to use larger factors of safety. To keep pace with the general advance there must be a future trade, highly skilled, to place concrete so the designer may be assured of existing conditions. The lack of such a skilled trade has been instrumental in retarding the use of concrete. Methods of field control from the batching of materials to the setting of the formed concrete must progress before the designer can advance his working stresses to a higher value. In order to eliminate the human element as much as possible, I see a future field plant mechanically grading, proportioning, and timing each batch. Might I even go so far as to say that even batch mixing will be abolished in favor of continuous mixing such as we now have in the modern cement mill. Conforming to this increase in standard, testing engineers will devise a method of sampling materials during the mix and determining, at once, the ultimate product. Thus poor mixes can be corrected, or condemned, before being placed in the forms. These improvements are needed today, but will be demanded tomorrow.

Out-of-Date Code Requirements

Many designers are held down to low working stresses by local building codes. The political inertia of these codes is tremendous. Take as an example the city of Chicago, the industrial leader of the country if not the world. The Chicago code still specifies that 2000 lbs. per sq. in. shall be used for the ultimate stress in a 1:2:4 mix. Yet we years ago discontinued specifying the mix by arbitrary proportions. Is the surgeon confined by code or specification as to how he will perform an operation? Neither will the future designer be confined by political codes of practice. This will, however, necessitate designers of better ability than the average run of today.

Economic reasons should warrant consideration of all materials available. Why should we arbitrarily say that either concrete or steel is the final word? Structures in the past have been criticized for the joint use of these two materials. But is it not logical to use each where it is most economical? An unbiased opinion is always essential for maximum economy.

Definite Determination of Stress

The methods of stress analysis, at present in use, are largely approximate and frequently but a wild guess. Several years ago during a conference with a former building commissioner, the question of continuous beams came up. I suggested a simple, yet reasonably accurate, solution of the problem. This former commissioner protested that a Chicago building could not be designed by such methods since the code specified that, for the case in question, the bending moment should be computed by the formua ($wl^2/10$). A consulting engineer came to me with a problem on the design of a reinforced concrete circular storage bin. He said they were taking a vertical segment and investigating it for stability. How many railroad signal bridges have been designed as a simple beam supporting the vertical loads, with the columns designed to withstand wind loads. Then a knee brace added as an afterthought. All wild guesses, entirely safe I must acknowledge, but are they economical? Refinements of material, methods of construction, and increased working stresses, will force the designer to stress computations of comparable accuracy. I am convinced that the present mathematical methods of stress analysis are inadequate. Every structure is indeterminate to some degree although we neglect the effect of deflection and deformation in many of the so-called statically determinate structures. Methods such as slope deflection and least work have too many points of uncertainty as well as difficulty. The stress analysis of the future will take no chances with such uncertainties. The stress analysis of the future will be made from a model. In using the Beggs deformeter gauges in 1924, I applied the two dimensional models to commercial structures for the first time. My prophecies of that time have been well verified. W. G. Hayden, designing engineer of the Westchester County Park Commission, has been able to make some notable improvements in overhead crossing bridges by using this method. The limits number of three dimensional model applications already made have opened up a multitude of future possibilities. There is also a general tendency toward simplicity to the elimination of much of the hokus-pokus of design. It was my aim in presenting the series of charts now running in CONCRETE. Professor H. J. Gilkey of the University of Colorado had the same idea when he independently worked up similar charts. Sutherland and Clifford aimed at the same thing in presenting the transformed section in their analysis of reinforced concrete. Accuracy, sureness, and simplicity will become more predominate in the stress analysis of the future.

Apparatus for model analysis of Yadkin river bridge

Shrinkage stresses, due to changes of volume, have long caused the designer trouble. I anticipate that future concrete will not change in volume, or at least such shrinkage will be under control.

Reduced Design Loads

Now as to the contingencies of tomorrow. What loads will be applied. How hard will the wind blow? How much snow shall we allow for? The recorded weather data of today make such probabilities less uncertain Let me even go so far as to express a belief that at some future date the weather will be controlled by science. Excess heat of the summer will be used to modify extreme cold of winter. When temperature is under control, the allied phenomena such as precipitation and wind, will also fall in line. Professor Alber Smith demonstrated years ago that our methods of applying wind loads was in serious error. If the suction effect of wind was neglected in aeroplane design, that industry would be far behind its development. Human and merchandise loads will in all probability be more difficult to anticipate. But most designers know that their design loads are far in excess of anything that can possibly occur.

The engineering profession has been trailing the medical and legal professions, although far behind. The former general practitioner took care of the mother, brought the child into the world, took care of him during sickness, and operated when necessary. I remember quite well at the birth of our first child when the obstetric specialist, who had saved the mother's life after a general practitioner had made a serious mistake, recommended a baby specialist. He stated quite frankly that he knew nothing about babies although he had five of his own. The engineering profession will some day be unafraid to confess its ignorance and refer matters to someone who knows. In order to analyze accurately the stresses in a complicated structure a man might devote his entire life to that one field and still know but comparatively few type structures. We cannot know it all, so why not confess our limitations and quit trying? We will some day have highly trained specialists in the different branches of design, functioning only in their particular field. Designing a building from the foundation to the complete structure will require the co-operation of the many highly trained specialists working as a group.

I would say that consistent accuracy will be the keynote of future design. Accuracy depends upon many factors and each can progress only as the whole. So I have perhaps transgressed into other fields than that of design. Yet design must consider all factors. The strength of any structure is determined by its weakest member.

Cast Stone

—An Industry That Appreciates Its Possibilities and Acts to Take Advantage of Them

By AUSTIN CRABBS
The Cement Products Company,
Davenport, Iowa

CONSIDERING the present magnitude of the cast stone industry, it seems strange to find so much lack of information, and so much misinformation regarding this meritorious building material. Architects and potential users are prone to think of manufactured stone as an artificial substitute, when, as a matter of fact, it has inherent properties and possibilities not to be found in the natural product. This condition is the result of individualism through which each manufacturer has been his own promoter and has thus been able to present his subject only to those with whom he has come in personal contact.

With the organization about a year ago of the Association of Cast Stone Manufacturers, the first move was made toward national recognition of this material, and in one year's time two other important steps have been taken. The first of these was the adoption of the name "cast stone" to apply to any ornamental product made of portland cement and aggregate, regardless of the process used. And the second step was the formulating by the American Concrete Institute of a standard specification as a guide to architects and builders who might desire to use this product. These new developments coming so close together are prophetic of the fact that the giant is now awake and that from now on rapid strides may be expected.

In fact, we are facing an era of rapid expansion in the cast stone industry and as it gains momentum, we may look for a veritable "gold rush" of those who see an opportunity for big profits in an expanding market. This, of course, will lead to the inevitable over-expansion that is one stage in the development of all industry.

Already we see on every hand small cast stone plants springing up and a word of caution would not be out of place at this time. Many of these plants are doomed to failure through improper managing or financing, but as the development progresses, there will be, dotted over the country, individual firms making a high grade of cast stone and performing a service that would be a credit to any community. The era of expansion that we are facing will mean, as has been the case in other industries, that we may look for a time when too many factories are making cast stone, or in other words, that supply will exceed demand, and the next step will be a gradual process of elimination, to see which are most fitted to survive.

This stage has already been reached in the field of hollow concrete building units, where there has been a decrease in the number of plants in the past few years of about thirty per cent and this in spite of a substantial increase in total output. Much of this internal competition could be avoided if those contemplating engaging in the business would first make a more careful study of the potential markets and even a more careful study of their own fitness for the particular business. In cast stone, as in all other industries, we have a great economic problem, occasioned by the desire of individuals to duplicate the success they see others making and in starting a new business, they too often do not realize till it is too late, that the field is already filled and that they only complicate matters by increasing supply over demand. Some day we will learn to control these conditions in our economic structure, and when we do, the waste from overproduction will be eliminated.

However, in spite of and through the struggles of individual firms, the cast stone industry as a whole is destined to see a tremendous growth during the next few years till it takes its place among the major building materials of the country. That our competitors in other lines have begun to knock, is evidence that they have begun to fear us—and they have reason for this fear. Natural stone, in addition to being hard to secure, is usually taken about as it comes, and cannot be controlled in structure and quality like cast stone. Other materials used as trim have defects not found in our product. And when, as is now the case, manufacturers or producers of competitive materials begin to look around for an opportunity of entering our field, you may be sure that cast stone is fast coming into its own.

P. G. RILEY
President

P. G. RILEY
GENERAL CONTRACTOR

~~701 Temple Street, Pottstown, N. Y.~~

T. G. McGOVERN
General Supt.

Los Angeles

Dear Mac:

My old friend, John Brundage, retired mixer manufacturer, spent the night with us the other night, Mrs. Brundage being in the East visting a new grandchild.

Mother had gone to bed and John and I were enjoying ourselves rehashing some old arguments, when finally I said, "Let's quit talking about the past, for that's a sure sign of old age. What about the future, say of the building industry, or that part of it we are interested in? Just [illegible] you are as active in this industry in reality as your mind is. How does the future look to you?

"Well, P. G., I would say it is in rather a chaotic state, caused by the back-[illegible]t and fiction relating to the whole industry. We hear rumors to the effect that equipment f[illegible]y used by contractors must now be discarded, rumors that concrete, the manufacturing of which was a profitable part of the contracting business, will be manufactured and sold to the contractors and possibly later on, to the owners, thus furnishing more competition, especially "jackleg" competition for established contractors. Consolidations have caused rumors to the effect that small worth-while, independent manufacturers of equipment, also small, but worth-while equipment distributors, will eventually be washed out."

"Yes John, old son," I butted in, "That's the present, but what of the future?"

"Well, personally, P. G., I think this is just a phase in a part of our economic changes and that in the near future people will learn that consolidations are not the solution of all problems and that in the economic scheme of things, the so-called geniuses and leaders of the construction industry will eventually learn that while we are in a cycle of changes and about the only thing, someone has said, we can be sure of, is change, there is one point that apparently is overlooked and that is that human nature remains the same and that ability cannot be corralled in one or two pots.

"The worth-while contractor is not going to be stampeded by rumor into deliberately placing his head in a noose and even though he has known considerably less than he should about the things he has been paying his money for, (pardon me, P. G.) he is going to wake up now and pay some attention to design and quality, upkeep and speed of operation of the equipment he buys and won't be influenced as much as he has been in the past by wild trade-in offers or by mere talk or rumors. He will buy equipment on its merits from whomever puts the most brains in it, regardless of the size of the manufacturing concern who makes it or the size of the distributor who sells it, or the wind capacity of either. He is going to see to it that the equipment he buys is made to efficiently do the work he has for it to do, instead of being designed to meet a merchandising problem."

"Yes, but John—"

"Now, wait," says John, "if you start arguing we never will get to bed."

There you are, Mac, and old John should know his stuff.

Sincerely yours,

PG

This is the eleventh letter of a group whose publication began in the May issue of CONCRETE *written by P. G. Riley, retired contractor, to his superintendent, Tom McGovern, back home. "P. G." is taking his ease in California and the distant fields, where he was once so active himself, look mighty green to him.*

Perhaps his greatest pleasure is in keeping touch with his superintendent and, off and on, his secretary, Anna Ryan. His being away from the scene of activity has given P. G. some new viewpoints and he manages, in his letters, to convey to the young folks some of the ideas in the back of his head. One of the bits of advice he has already given "Mac" concerned the wisdom of investigating operating performance when buying equipment. At another time he told Mac of the "catch" in the seemingly attractive trade-in offer. There's a lesson, too, he said recently, in not letting old, inefficient equipment eat up the profits.

In another recent letter "P. G." passed on to Mac a little incident he had heard about, to the effect that horse trading tactics in equipment buying are not the best way of doing business.

When, Why and How Shall We Test?

By CLOYD M. CHAPMAN
Consulting Engineer, New York City

Are our present testing methods adequate for concrete work of the future?

Are testing methods developing at a rate comparable to progress in other branches of concrete construction?

Will the growing tendency to transfer testing from the laboratory to the job affect testing methods and equipment?

If we are not progressing in this field as rapidly as we should, what changes are needed?

How do testing methods affect the quality of the concrete produced?

Can we improve the quality of the concrete by improving present testing methods or by developing new methods?

There are some very constructive suggestions on these subjects in the accompanying article.

IN the concrete industry advantages of quality, economy and speed are on the side of those who know their materials, proportions and product. To that thesis volumes could be dedicated. In so brief an article as this only a short summary can be given.

Testing in the concrete industry is still much underdeveloped. But the rate of development is accelerating in a very hopeful degree. One of the encouraging signs of progress is the fact that some of the most venerated tests of yesteryear are no longer considered sacred. Another encouraging sign is the growing tendency to transfer testing from the laboratory to the job. Thus the man who makes the product is in closer touch with tests and ready to take instant advantage of their results. As testing methods and apparatus are simplified this tendency to test on the job seems likely to grow.

Quite aside from the question of where tests shall be made are those which relate to what tests shall be made and how. To start with the raw materials, consider first the cement. The standard tests for portland cement have undergone but little change in many years. Undefendable as they are, they will have to suffice until something better is developed, which appears possible in the not-far-distant future. That venerable old holy devil, very old but still very fickle, the one-to-three standard and briquette tensile test, here one time and there the next, seems likely to lose the respect and veneration of the industry. The sooner that old rascal passes the better off we will be.

Cement Testing

The fineness test as applied to cement is emphasized chiefly by those who are interested in the more finely ground products. Higher early strengths result from finer grinding, but so does greater volume change and tendency to produce laitance. Very fine grinding is not an unmixed blessing. Years ago we heard and said a great deal about soundness tests for cement. In some manner not fully understood the durability of concrete was said to have some relation to the ability of a pat of the cement to retain its form and freedom from cracks when subjected to hot water or steam at a pressure of one atmosphere or several atmospheres. The test is still made but the effort to associate disintegration of concrete with unsound cement which was once so common has passed into limbo.

Chemical analysis of portland cement is seldom required or necessary. The manufacturer must take proper care of composition to successfully meet the other test requirements of his product.

To the user of portland cement none of these tests are of so much value or even interest as tests of the qualities of the product produced by the cement in question when combined with the aggregate to be used. The user may, with much greater degree of safety, devote his attention to aggregates, proportioning, mixing and placing to the exclusion of the cement than vice versa.

Aggregate Testing

With aggregate there is a very different situation but one which the producers of aggregate are recognizing and taking active steps to correct.

Scarcely two of the many available aggregates are as much alike as each brand of standard portland cement is like every other brand. These wide variations in aggregates make it possible to choose the means to gain the end desired. Upon whether the desired end be density, compressive strength, transverse strength, wear resistance, impermeability, fire resistance, lightness, weight, color, appearance, or what have you, each combined with economy, will depend the choice of aggregate. In many cases the selection may be made without comparative tests, either by process of reasoning or in the light of past experience. For example, one would not buy light aggregate to build a gravity dam or use siliceous gravel in place of limestone for fireproofing. But there are many ends to be attained that are not to be so easily reached, and in most of those cases comparative tests furnish the shortest, surest route to the goal. Of course it is well known that certain classes of aggregates have certain characteristics. A sharp angular crushed material of a given gradation will give a harsher concrete than a well rounded water-worn material of similar gradation. Such general knowledge does not, however, furnish an answer to many of the most important questions that confront the maker of concrete. The question, therefore, is what tests shall be made? and why? and how?

Without attempting to place them in any order of either real or relative importance, since the order would differ for various purposes, we will consider some of the qualities or characteristics an aggregate must be known to possess or to lack in order to make concrete suitable for certain uses, and how those qualities or characteristics are to be determined.

Size

Perhaps the most commonly specified characteristic of an aggregate, either fine or coarse, is its size. Not only the maximum and minimum limits but its gradation within those limits are commonly fixed and tests required to determine compliance. Tests for size are relatively easy and simple and except for the finest sizes are made with sieves. The test is satisfactory and subject to but little improvement. The chief bone of contention is whether square or round hole sieves shall be used. One is as good as the other. It is merely a matter of choice.

The finest sizes of particles present in aggregate are commonly separated by washing or so-called decantation. The satisfactory character of this method of test as a measure of either the amount or the deleterious nature of the fines so determined is open to considerable question.

It is common in specifications for fine aggregate to place a very low limit, usually 2 or 3 per cent, and rarely above 5 per cent, upon the permissible amount of fine material which will pass a 100 mesh sieve or will be removed by decantation.

Some very excellent aggregates contain much more fines than present specifications commonly allow, yet are capable of making concrete admirably adapted to certain uses.

The past and present widespread objection to the presence of any considerable amount of very fine material—sometimes called silt even though it may not be at all of the nature of silt—is probably due to the known deleterious effect of certain classes of very fine material sometimes found in dirty sands. Some crushed rock screenings containing as much as 20 per cent of fine material passing a 100 mesh sieve makes excellent concrete while 3 per cent of silt in bank or river sand may render it useless until it is washed. Present specifications or methods of test should be improved in respect to fines. Either the quantity of fines permissible should vary with the character of the fines, or a method of test should be used which will differentiate between helpful and deleterious fines. In this respect present testing methods are inadequate.

Shape

Since the early days of the industry, it has been common practice to exclude by specification an aggregate having particles which were described as "thin," "laminated," "long," "slender," etc. How thin or how long a particle must be, or how many of them must be present, to cause rejection was not stated. A little progress has been made of late in this matter, but it requires further attention. For the present the eye of an intelligent inspector is the test. If many odd-shaped particles are present in the aggregate, beware of it. Balls and cubes will pack much more tightly than a mixture of odd shapes.

Toughness

With the ever increasing construction of concrete pavements and wearing surfaces, and the constant effort to improve their quality and lengthen their life, there has developed a demand for a method of test which will permit some reliable predetermination of durability. The efforts made to develop such a measure of durability have centered around abrasion tests of either the Deval or the Rattler type. Tentative methods of tests for loss on abrasion have been promulgated by A. S. T. M. and it is hoped that much careful investigation will be applied to the problem of developing reliable methods. Judging from the progress made to date, it would appear that a method using some form of rotating container within which is tumbled a mixture of aggregate sample and abrasive units may be found which will give the desired result.

Such a method or a modification of it might also be used to determine the presence and quantity of what is now commonly but vaguely referred to as "soft friable" particles, and which the aggregates must be "free from" to meet the usual specification.

Resistance to Weathering

Resistance to weathering is usually known as "durability" or its opposite "unsoundness." The determination of this quality in an aggregate, particularly coarse aggregate, has caused much discussion. Freezing and thawing tests require considerable equipment and the interpretation of results is admittedly not a simple matter. The sodium sulphate test and the salt test both offer possibilities but to date the art of using them and interpreting the results have not been developed to a degree warranting universal adoption.

There is one test, however, which should be applied to crushed rock aggregates. If the exposed rock ledges from which an aggregate is quarried show weathering upon exposure, beware of such aggregate for exposure to similar weather conditions. A rock that will weather in the ledge will probably weather in concrete.

The terms moisture and absorption are coupled because of their close relationship. Moisture may be surface moisture, absorbed moisture, or the sum of the two, which is total moisture. A knowledge of the surface moisture of a damp sand or the absorption of a dry sand is necessary to the accurate application of the water-cement ratio theory. A change of one per cent in the moisture content of the aggregate in a 1 to 4 mix makes a difference of a half a gallon of water per bag. That is far too much to be ignored when high grade concrete is the objective via the water-cement ratio route. There are several available methods for determining moisture. Drying to constant weight either in an oven, over a heater or by burning off alcohol which has been added to the sample, are all sufficiently accurate for determining total moisture, that is, surface moisture plus absorbed moisture, but they are subject to the objection that since only the surface moisture is considered as forming a part of the total water in computing the water-cement ratio it is necessary with these drying methods to also make a determination of absorption of the sample in order to make proper correction.

There is a second method, which consists in measuring the difference in displacement between a wet and a dry sample of the same sand. Various pieces of apparatus have been devised for conveniently making this determination. One of these has been adopted as a tentative standard by A. S. T. M. By this method the surface moisture alone is quickly and easily determined within a suitable degree of accuracy and without mathematical calculations. The time required to complete a test is less than five minutes.

Moisture tests of aggregate are relatively very unimportant except when the water-cement ratio method of design is used. Absorption, on the other hand, and especially the absorption of the coarse aggregate assumes an added importance when very impermeable and nonabsorbent concrete is required. Concrete having a low absorption factor is more likely to result when aggregates of low absorption are used, provided proper attention is given to other factors.

Other Tests

There are, of course, other tests for other qualities which at times, for specific purposes, are more important than any so far mentioned. Fire resistance is one of them, or resistance to attack by specific materials which it is known will come into contact with the concrete in service. In those cases, where any doubt of suitability exists, carefully planned tests should be made to determine whether the aggregate may safely be used.

Design Tests

By the term "design tests" are meant tests made for the purpose of fixing the materials and proportions to be used on the job to secure the desired results. They are of the greatest importance to the success of the work. The procedure to be followed has been standardized to but a very small degree. For compressive strength tests there is a well established procedure for making, storing and testing the specimens. But for tests to determine other qualities of the finished product, there is urgent need.

Whether standard tests are available or not, when an aggregate is to be used on large and important work to make concrete which must possess certain characteristics, and if that aggregate has not demonstrated in previous service its suitability, then proper tests should be applied before risking construction. It is in such cases that the well equipped laboratory and the experienced testing engineer can be of great service.

Probably no decision on a job where concrete having particular qualities in a high degree is required is more important than the selection of the mix to be used, the water, the cement, and the aggregates, and in some cases the admixture.

Here is a case where one of the most important classes of tests in the industry has received the least amount of standardization. The engineers of the industry should correct this defect. It would be a great help if more results of tests were published. A number of systematic investigations have recently been made and others are about to be made to ascertain which of several available aggregates and what size grading of those aggregates is best suited for a special service concrete. In the localities in which those particular aggregates are found such tests are very helpful and their publication would aid others.

Until there is much more test data available, or until test methods are more generally standardized, it will be the duty of the engineer to make such tests as in his judgment are best to aid in his design of the mix to be used.

Control and Acceptance Tests

Under the heading of control and acceptance tests are included such tests of the finished product as are made to determine its fulfillment of the specifications or its deviation from the designed standard, or for other purposes such as to ascertain when forms may safely be stripped or when a pavement or structure may be put into service.

In the past and even at present, such tests have been confined much too exclusively to strength tests, either compressive or transverse. This practice is based on the assumption that the strength of concrete is an index of its other qualities, density, absorption, resistance to abrasion, etc. It is assumed that if a concrete has a high strength it must have all the other qualities desired in it. This is sometimes so but it is by no means universally true and should not be assumed to be a fact without careful test.

It is very easy for a concrete producer to acquire a very self-satisfied and contented feeling when he thinks that his concrete was very carefully designed before the job started and the work was very well inspected, therefore his product must be just what he wants it to be. Every once in a while one of that sort of concrete makers tries testing the product for some purpose or other. Often the first thing discovered is that the product is not as uniform as had been supposed, that while some is good some is not so good. The next discovery is that in reducing the variableness of the product he has raised the quality of all of it. He finds that now his poorest product is about as good as his previous best, and he dates his conversion to the policy of testing his product from the time of that discovery.

Let us consider a few of the tests which are commonly applied to finished products and note their value or usefulness. Since strength, compressive or transverse, is the most commonly made test, we will begin with it.

A maker of concrete finds, for example, that he has been using six and a half bags of cement per yard of concrete to produce what he believed to be 3000 lb. concrete, as the specification contemplated. A few test specimens, however, show that the strength is running less than the expected amount. Shocked at this he gets busy and before long finds that he can not only make 3000 lb. concrete with six and a half bags but can also do it with five and a half bags.

Incidentally, while learning how to make stronger concrete with less cement he also found that by varying the mix and the procedure somewhat he could get the strength at three days that he had previously supposed could not be had under seven days, and that he could strip forms or put a piece of work into service in less than half the time he had been in the habit of doing. It is not a difficult matter to attain high early strength concrete, but the fact that the high early strength has actually been attained should be verified by test specimens cast at the same time and from the same concrete as the structure before taking chances with the structure. The test is the safeguard.

Another quality of concrete which has caused a lot of discussion because it is so often present and so often absent is permanency, resistance to disintegrating influences.

Of all the theories advanced to explain why this or that concrete structure has disintegrated, why this sea wall or that bridge abutment spalled off, how many of them do not start with the assumption that the failed concrete was permeable? Occasionally we run across a case of disintegration or spalling that may be convincingly accounted for without assuming the concrete to have been permeable. Lime may have swelled and caused popping or some constituent of the aggregate may have caused a swelling, or in rare cases an unsound cement may have been responsible.

But in most cases percolation, permeation, solution, crystallization, deposition, freezing are the basis of the explanation. And every one of them are in turn possible only in a permeable mass. The more nearly impermeable concrete can be made the longer it will stand up against the influences of disintegration. Permeability is influenced by several factors, the kind of material in the aggregate, the grading of the aggregate, the proportions used, including the water, the method and time of mixing and the method of placing. With such an array of variables is it conceivable that there is a method of arriving at the best result except that of trial and test?

The state highway departments have found that testing as they go is highly profitable. A test specimen cured alongside the road tells when the pavement is in condition to receive traffic. It also tells things under some circumstances which might otherwise remain mysteries, because by the retention of these specimens a sample is available for ready reference when any defect or peculiarity develops in the section represented by the sample.

The tendency of the times is undoubtedly toward better test methods and more tests. There are several types of tests, however, which still remain to be developed. We have as yet no method for determining uniformity of concrete, or of the concrete mixture. Neither have we a satisfactory test for workability.

The past twenty-five years have seen great advancement, but the greater part of it has occurred in the latter part of that period and at the present accelerated rate of progress the next five or ten years will see much greater improvement in methods of test for concrete and concrete materials.

OUR FIRST ISSUE

WHEN CONCRETE made its first appearance in March, 1904, it did so without any pretentious gestures. The magazine itself was modest enough, consisting of one 32-page form bound in a gray paper cover.

The very first sentence of the first editorial in CONCRETE, however, stated in a straight-forward and unmistakable manner the purpose of the paper,—we can add nothing but emphasis after the lapse of 25 years.

"In presenting the initial number of CONCRETE we desire to say that our purpose is to advance the interest of those engaged in the manufacture of cement and concrete construction in all of its forms."

So reads the editorial. It continues: "The encouragement already received, as well as the present activity in the different branches of constructive industry, more than justifies our view that there is a broad field for a live publication, in this line. This is the beginning of the concrete era. For a number of years past the best energies of the country were devoted to the mining, manufacture and improvement in iron. We have just passed through a wonderful and all too rapid development in the steel industry, which has culminated in the greatest corporate combination the world will probably ever witness and from which a reaction is inevitable.

"Contrasted with this, the development of the cement and concrete industries of this country has been conservative and stable. While we were exporting steel, cement was being imported; and not because of any lack of natural resources. Rather because industries, like history, move in cycles. Today the cement works of the United States may safely be said to equal if not excel those of any European country, not alone in the supply of raw cement material and factory equipment, but in the quality of cement manufactured. No longer is it thought necessary to have a halo of 'imported' around the cement specified for important works. Standard American brands are today considered the equal of any throughout the world, and can be used with even a greater degree of safety here than imported brands, because of less danger of deterioration from storage and transportation.

"In the application of cement and concrete to constructions of widely varying classes, France and Germany have exceeded us, though, measured by the work done in all parts of our country during the last few years, it will not be long before the concrete bridges and buildings of America will surpass those of all other countries.

"In no field today is there such great activity as in the manufacture of cement and the application of it to a rapidly increasing variety of uses. The pioneer work has already been done. Constructions ranging from concrete sidewalks to reinforced concrete office buildings, railway bridges and cast stone houses and grain elevators, are to be found in nearly every city and town, the precursors of a new and better building era, in which absolute permanency is to be a factor.

"We have before us a report upon the condition of the Brooklyn Bridge, completed in 1883, in which Bridge Commissioner Lindenthall recommends an entire rebuilding. The report says that the structure is in a worn out and weakened condition, requiring constant and expensive repairs to keep it safe, and that a rebuilding of the bridge has become imperative. Steel railway bridges have an average life of from fifteen to twenty years, while steel-framed terra cotta buildings have a life expectancy of only thirty to fifty years.

"In addition to these fields, concrete will be called upon to provide the breakwaters, docks, irrigation reservoirs and ship canals. Its use in other perhaps minor directions will also be extensive. Discussions of the best methods of handling and new uses to which cement may profitably be put will be of more than pecuniary value."

We have quoted the editorial at length not only because it furnishes a view of the industry as it existed in 1904, but because it also carries within itself a few modest predictions which have an added interest in the light of their fulfillment.

Among the other material which made up this first issue we find a long article on the "Marl Deposits in the United States," a discussion of concrete block, illustrated with a photograph of a six-apartment building built apparently of 36-in. rock faced block. There is a discussion of concrete railway ties (a use of the material which has not yet become general), a discussion of reinforcing, and an attractive illustration of the concrete hotel and depot buildings built by the Atchison, Topeka & Santa Fe Railway Company at Albuquerque, N. M. A couple of very unusual concrete mixers are illustrated, one of them being equipped with an elaborate system of three bucket conveyors for elevating the materials from the ground level to the mixing cylinder. Among the news items is a rather irrelevant bit of information about the failure of a steel frame building which collapsed in the course of construction.

The advertising content of the issue was not very heavy, and many of the names included are now unknown to the industry. Among the various pieces of equipment advertised, however, there appeared the Smith mixer, looking very efficient and workmanlike, pretty much the same as it does today.

The subscription price set on CONCRETE when its first number was issued was $1.00 per year, and subscribers whose subscription started with the first number were guaranteed that price for life.

It is interesting to note that a number of these charter subscribers are on our list today, still receiving the paper at the very low price originally guaranteed to them.

Creating Order *out of* Building Code Chaos

By NORMAN M. STINEMAN

Structural Engineer, Portland Cement Association, Chicago,
Specializing in Building Code Work

FOR the last six or eight years building code regulations have been in a state of flux. Activities of recent months indicate that this condition will continue for several years to come.

The trend in the future, as in the past, will in all probability be in the direction of greater uniformity. It is a fact too well known to require repetition that when the Department of Commerce building code committee started its building code studies in 1921 the requirements of city building codes varied over a wide range. A typical illustration of such variation in requirements, even in the same localities, was brought to this writer's attention not long ago in two New England cities adjoining each other, with a street as the dividing line. Two dwelling houses of two stories each were under construction at the same time, on opposite sides of this street. Each one was being built in accordance with the minimum requirements of the city building code by which it was governed. One building had a 16-inch foundation wall of concrete, and 12-inch brick walls in both stories. The other had a 10-inch foundation wall of concrete, and 8-inch concrete block superstructure walls, coated with stucco.

With such variations prevailing in adjoining communities it is not surprising that building regulations are not always accorded the respect so necessary to their successful enforcement. Building regulations are too often looked upon as a necessary, or perhaps an unnecessary, evil, a feeling that is fostered by inconsistencies of the kind just described.

Is a nation-wide uniform building code possible, and if possible, is it practical?

Already much has been done to untangle the knotty problem of absurd variations in individual building codes. State and regional codes have been adopted and are operating with outstanding success.

Is the next logical step a model national code prepared by a committee made up of representatives of each of the regional code committees?

Unless modern building codes prevail, many of the advantages that could result from better design and from quality control of concrete are difficult or impossible to attain. All these matters are interdependent, one depending on another, and unless progress is made in every branch, the progressive branches are held back.

All forward looking contractors and engineers are vitally interested in building codes and should support movements that aim at code standardization made in the light of modern knowledge of concrete control.

Early Efforts at Unification

The Department of Commerce building code committee saw these conflicting or widely varying conditions repeated in a hundred different directions. Work was started by making a thorough analysis of existing building codes, after which the committee developed what might be considered the safe minimum requirements for various conditions. The Department of Commerce committee has now issued one report governing dwelling house construction, another covering masonry wall construction, another on minimum live load requirements, still another on working stresses in basic building materials, and another on plumbing. At the present time the committee is approaching completion of a report on fire-resistive requirements, this report having just been issued in tentative form.

The reports issued by the Department of Commerce building code committee, though not constituting a complete building code of themselves, have nevertheless exerted an immense influence on recent building codes. They have also stimulated the movement toward a complete uniform building code which may eventually result from the work already accomplished.

Efforts toward the development of complete uniform city building codes have been confined thus far to individual states, or to regions comprising several states. The first of these documents to appear in print is the proposed uniform code prepared by a committee of the Pacific Coast Building Officials' Conference. That organization was formed in 1922 for the purpose of preparing a model city building code, but it was not until about September, 1926, that the preliminary draft of the code appeared in book form. This preliminary draft was thoroughly reviewed and criticized. The final draft, known as the 1927 edition, appeared in book form early in 1928.

Regional and State Codes

The second organization to undertake the preparation of a model city building code was the Building Officials' Conference of Florida, organized in July, 1926. That organization employed the preliminary draft of the Pacific Coast code as a basis for study, and that code was followed quite closely in outline as well as in the regulations recommended. The Florida committee was able to readjust some of the provisions in line with the final draft of the Pacific Coast code. Some modifications were, of course, made, among which might be mentioned the greater utilization of fire-resistive types of construction.

At the annual meeting of the Building Officials' Conference of Florida, held in November, 1928, the final draft of their model code was adopted with some minor changes. The code committee was authorized to incorporate the changes before the document is issued in book form at an early date.

The Massachusetts Building

Officials' Conference, which will probably be enlarged to include all of New England, has taken preliminary steps toward the development of a model city building code. It is expected that a model document will be written on the basis of the laws of Massachusetts, after which committees representing other states will analyze the model and make notation of the changes necessary to conform to the laws of their respective states.

In Illinois the Building Inspectors' Section of the Illinois Municipal League appointed a committee in September, 1928, for the purpose of preparing a model city building code in detailed form for the larger cities and in condensed form for the smaller municipalities.

In October, 1928, the building inspection officials of a number of Ohio cities organized a state chapter of the Building Officials' Conference of America, the principal purpose of this organization being the preparation of a model building code which all Ohio cities can use as a guide.

In January, 1929, the League of Nebraska Municipalities appointed a committee to prepare a model city building code in complete form for the larger cities and in condensed form for the smaller cities and villages. Steps were taken at the same time to foster a legislative bill authorizing municipalities to adopt standard building regulations by reference instead of requiring their printing and publication in detail. The proposed bill sponsored by this organization is similar to a law passed in California in April, 1927.

On February 8, 1929, the building inspection officials of a number of Indiana cities met in Indianapolis and formed the Indiana Building Officials' Conference. Here, as elsewhere, the principal purpose of the organization is that of developing a model city building code, in detailed form for the larger cities and in condensed form for the use of small municipalities.

On February 26, 1929, the Southwestern Building Officials' Conference held its organization meeting in Shreveport, La. The purpose of this meeting was the same as the others already enumerated, namely, that of preparing a model city building code for the use of cities in Texas, Louisiana, Mississippi, Oklahoma and Arkansas. The code adopted as the basis for discussion is the present building code of Shreveport, a modification of the Pacific Coast code.

On February 27, 1929, the New Jersey State League of Municipalities appointed a building code committee to prepare a model city building code for cities of that state. A special building inspectors' section of the league was formed to prepare the proposed model code.

On February 28, 1929, the Southeastern Building Officials' Conference was organized in Atlanta, Ga., also for the purpose of preparing a model city building code. It is quite probable that this organization will follow the code prepared by the Building Officials' Conference of Florida, with such modifications as the code committee deems advisable. The Southeastern Building Officials' Conference comprises cities in the states of Georgia, Florida, Alabama, Tennessee, Virginia, North Carolina and South Carolina.

The list of organizations just enumerated appears quite formidable; but the existence of these state and regional organizations carries particular significance when one reflects that all but two of them have initiated their work within the last twelve months.

Is a National Model Code Practical?

The work now under way toward the development of modernized building regulations in so many different states and sections suggests at once the possibility that there will be considerable divergence in the regulations recommended. This may well be expected. Nevertheless, if we grant that the model codes fostered by these separate organizations will not be uniform, we will at least have the advantage of fairly uniform requirements in the cities of any individual state or larger region coming within the scope of one of these models. This will be a decided improvement over the former situation, when the code of every city differed from that of every other city.

The prediction is made, however, that the activities of these various organizations of building officials will open the way for the next logical step, namely, the preparation of a complete model building code written by a committee of nation-wide scope. Such a committee might well contain representatives of each of the separate organizations engaged in the preparation of model building codes, with an additional membership drawn from the small group of individuals who have familiarized themselves with the essentials of building regulations.

The need for a complete model code of national scope will become more and more evident as the work of the building code committees of the separate organizations approaches its culmination. It is not presumed for a minute that a model building code of national scope could be devised that would suit the requirements of all sections.

Even if a model code of nation-wide scope were now in existence the present state and regional organizations of building officials would nevertheless be necessary. Each organization would make such modifications of the national model which appeared necessary or desirable. Changes made by one state or regional organization would differ from those made by another. But the final documents prepared by the separate groups would approach much closer to uniformity if they all used the same national model to start with.

The subject of working stresses is invariably one of the major subjects for discussion, during building code revision. This phase of building regulations, though unsettled at present, is approaching stabilization. As a general thing it may be said that higher working stresses are commonly accompanied, and properly so, by greater attention to design and supervision. In the District of Columbia, in Boston, Cleveland, Seattle, Los Angeles, and a number of smaller cities, provisions have been adopted requiring expert supervision of construction on buildings involving technical design and complicated construction methods. Many other cities have adopted provisions requiring similar expert supervision in varying degree. The adoption of higher working stresses in reinforced concrete, in masonry, and in structural steel, is a logical advance when accompanied by proper requirements dealing with design and supervision.

Summary

To sum up the trend, the following appears to be the situation that may be expected to reach its culmination within the next four or five years:

The cities of individual states, and in some cases those of larger geographical areas, will operate under uniform building regulations.

2. The trend toward higher working stresses, accompanied by better design and better supervision, will become stabilized at about the values now recommended by the American Concrete Institute and the American Institute of Steel Construction.

3. Actual adoption of building regulations will be simplified and made less expensive through legalizing of the principle of adoption by reference.

Concrete Technology, 1929~1934

By JOSEPH A. KITTS
Consulting Concrete Technologist, Kitts & Tuthill
Author of articles published in the May and September, 1928, issues of CONCRETE
San Francisco

PROJECTING the progress curve of the past into the next five years, a considerable advance is visioned in the general perfection of methods to predict the strength, durability and other qualities in concrete.

We are on the eve of general appreciation of the fact that production of concrete of quality with economy is a complex manufacturing process requiring scientific technique; scientifically prepared materials; production, placing, and curing equipment better designed to accommodate the scientific principles involved, and, correspondingly scientific specifications. The result will be the building of safer and more durable concrete structures at a lesser cost than at present, and the volume and variety of concrete uses will increase accordingly.

Many elements are working to effect this progress—individual scientists, public and private corporations, numerous local and national technical organizations, the rock products industry, the cement industry, the reinforcing steel industry, and educational institutions. Even the concrete workman is becoming a concrete minded and skilled artisan.

We have made great strides in the past few years in controlling the quality of concrete.

But have we gone far enough? Have we considered the matter of economy in connection with quality? Will 3000- and 4000-lb. concrete be produced more economically in proportion to its strength than 2000-lb. concrete?

Joseph A. Kitts, who contributed this article, has made some unusually thorough studies of concrete control from the point of view of economy. He believes that the question of strength per dollar invested will be of increasing importance in the future.

Future Manufacturing Control

The idea that concrete of predetermined quality may be made to some simple ratio, or formula of proportions, will pass into antiquity.

Laboratory control on the job, at the aggregate plant and at the central proportioning plant will become the rule rather than the exception on minor as well as major projects. This control will be maintained by a concrete technologist (and staff of engineers and physicists) representing the contractee, and the quality of materials and of concrete will be specified, not the ratio of ingredients. Accordingly, the materials, particularly cement, will be paid for as separate items of the contract.

The technique of aggregate and concrete testing will be systematized, co-ordinated, greatly simplified and made more efficient, expedient and economical.

The engineer and physicist will advance a step and think in absolute volumes of cement, admixtures and aggregate instead of being able to conceive only of superficial volumes including the unknown voids between particles.

Improved Proportioning Methods for Specific Quality

The basis of proportioning will be more scientific, more accurate, more practical and make a more efficient and economical use of materials for concrete of a particular quality. The absolute basis of proportioning will be the absolute volume of cement per cubic yard of concrete, the absolute volume of mixing water, and, the absolute volume of each uniform gradation of size of aggregate particles.

Concrete research will become the order of the day and daily routine on the major project. Comprehensive preliminary tests of the materials to be used and of concretes of various gradings and cement contents in absolute basis mixtures, will supply data of strength, density, impermeability, weight, etc., as a basis of economical design.

Formulas of strength based on the water-cement, sand-cement, aggregate-cement, cement-space, density of the concrete, quality and grading of the aggregate, quality of cement, mixing time, etc., will be developed and differentiated.

Aggregate Technology

Three to six sizes of aggregate will be used in concrete. Aggregate sizes (screen sizes) will be standardized on a rational scientific basis. Twelve-inch ring maximum size will be run through the mixers for mass concrete. Aggregate production will become a scientific process, and a great organized and merged industry.

The round-hole screen will become the standard for both the laboratory and the screening plant, excepting in the sizes under ¼-in. for which will be substituted square-hole screens of same screening value as the proper round-hole sizes.

Specified requirements for concrete mixing and placing plants will include: (1) self-cleaning aggregate bins, (2) dry storage for cement, (3) weighing hoppers for cement and aggregates (volumetric methods of measurement have been tried and found wanting), (4) mixer capacity for 12-in. aggregate and 5 cu. yds., (5) measurement of mixing water by specially adapted water meters,

(6) timing devices for mixing, (7) transit mixers, (8) mixer-trucks, (9) bulk cement handling equipment, etc., and these requirements will aid quality with economy.

The chuting system is here to stay and improvements for mobility and to prevent separation and spilling will be perfected.

Ready Mixed Concrete

Central proportioning plants with the acme of modern equipment will become urban concrete factories. This plant will have its laboratory and its physicist, chemist, testing engineer and concrete technologist. Here will be made concrete of any essential quality and in amounts of a fraction of a cubic yard up. It will no longer be necessary to assemble materials and plant at the site to patch a hole in the street or to build a skyscraper.

Economical Structural Concrete

Concrete of 3000 to 4000 lb. strength will be produced more economically in proportion to its strength than the present day 2000 lb. structural concrete and buildings will be designed accordingly with a saving of $0.05 to $0.25 per total square footage of floor area. Lighter and stronger arches of greater span are likewise made possible. Arch dams will be made with stronger, more uniform and more durable concrete without additional cost. A higher and more economical flexural strength will be used in highways with correspondingly greater durability, economy of upkeep and, hence, greater mileage.

Products Development

Concrete products vieing in quality and appearance with natural stone will be the result of research in this direction and technological control of manufacture will be the foundation of the success of this industry. A greater variety of products will result.

Pressure pipe of concrete for water-supply, irrigation and other hydraulic developments will be improved by the technique of proportioning and production control with greater assurance of durability and with economy.

Cement Development

Cement, a chemical mystery five years ago in its reaction in setting, will become an old story to the chemical engineer and he will make a cement of special characteristics for every special purpose. The strength producing factor of cement will be determined. Cement standards will be increased. The cement industry will greatly benefit by the cement technology and the concrete technology of tomorrow.

Admixtures

Admixtures to correct certain present day defects in cements and concretes will be established by facts and knowledge and those foisted by purely commercial considerations and without scientific proof will need to bear their burden of research to prove the product. Durability of marine and hydraulic works will be insured by proper admixtures, used with scientific skill.

Specifications and the Contractor

This new concrete technology with its scientific specifications will be attractive to the honest and competent contractor with modern equipment designed for quality production, while the cement skinning contractor with obsolete plant (he is the exception, perhaps) will no longer be a competitor with the specifications offering him large profits at a figure where the responsible contractor would be bound to lose.

Outlook for the Student

The concrete age appears to be here but the upward trend of the curve of progress, as seen by this prophet, shows that the scientific age of concrete is just beginning. The student of concrete, therefore, may be encouraged that his knowledge will be useful and of value to the general welfare and will be recognized and rewarded.

Work to the General Welfare

If the known facts of the physics and technology of concrete are applied during this year, 1929, the people of the United States will be richer to the extent of $100,000,000 or more and a correspondingly greater capital will be available to meet the general need for paved highways and other concrete developments.

Western Promise

California uses more cement per capita than any other area of equal population in the world. This per capita rate will increase. The largest masses of concrete the world has seen will be started here in the next five years.

Here in the West will be developed the concrete technology of the future to fulfill the requirements of 50,000,000 people.

The concrete world moves forward and no special faculty of prophetic vision appears necessary to the writer in making these predictions.

Indiana Building Inspection Officials Organize

At a meeting in Indianapolis on February 8th, the city building inspection officials of ten Indiana cities organized the Indiana Building Officials' Conference, with the view of preparing a model city building code in detailed form for the larger cities, and in condensed form for the smaller municipalities.

G. B. Bushnell, building commissioner of Elkhart, is chairman of the building code committee. Several cities have deferred consideration of revised building codes, in the expectation of utilizing the document to be prepared by the code committee.

Officers of the Indiana B. O. C. are Wm. F. Hurd, building commissioner of Indianapolis, president; the vice-president is D. Moomaw, building commissioner of Indianapolis, and the secretary-treasurer is T. D. Lee, assistant building commissioner of Indianapolis.

During preparation of the model code quarterly meetings of the organization will be held.

Steel Institute Prepares for Fifth Annual Meeting

Members of the Concrete Reinforcing Steel Institute who attend its fifth annual meeting on April 15th, 16th and 17th, will gather at the Kenilworth Inn, at Biltmore, near Asheville, North Carolina.

The program discloses the fact that there will be two regular sessions. The second of these, on the morning of the 16th, will be taken up with an address by O. W. Irwin, vice-president of the Truscon Steel Company on "Current Events," followed by another by W. S. Thomson, chief engineer of the Kalman Steel Company on "Engineering Costs."

The last evening's session will be devoted to a discussion of concrete ribbed floor construction, with a symposium on pan construction.

Pavement Surfaces *for* 40,000,000 Vehicles

By PAUL E. KRESSLY
Consulting Engineer,
Los Angeles, California

THE highways of the nation linking its cities, towns and rural communities, its industrial centers, its parks, mountains and sea, have been the backbone of the phenomenal growth of our transportation facilities and the advancement of human progress, and will in the future continue to be a dominant influence in the development of our country.

During the past years states, counties and cities have strained their resources to carry on road and street construction programs. While each year a new mark has been made in volume of pavement construction over preceding years, the use of the motor vehicle has increased faster than the mileage of improved roads.

In this connection, it is interesting to note what has been done and is to be done in the way of extension and improvement of our highways, especially that we now have 24,000,000 motor vehicles operating over more than 500,000 miles of improved highways. It is probable that during the present year an additional 4,000,000 new vehicles will be produced. The number each year will continue to increase as well as the mileage each car travels, so that with each new year the need for highway development will grow in magnitude.

Are Past Advances Sufficient?

The accomplishments of the past in the field of highway activities have been most significant, for which unstinted credit is due to all agencies and organizations represented in the industry. The engineers and highway officials, actuated by love of the work, unselfishly devoted themselves to this public service and their splendid achievements cannot but merit the praise and confidence of the public. Contractors, likewise, contributed no small part to this work. Ten years ago they thought in terms of manual labor and livestock, with partial machine assistance, while today they think in terms of machinery. As the development of road building progressed, they met the construction problems in an efficient and commendable manner.

Today's highway and street pavement construction is falling short of traffic requirements, in spite of tremendous advances in construction methods, equipment and design.

But even greater advances are needed to meet the demands of the 40,000,000 vehicles that will surely whirr over our pavements in the years not far ahead.

What effects will this new demand have on
- **—pavement design?**
- **—quality of concrete?**
- **—construction equipment?**
- **—volume of construction?**
- **—research?**

Mr. Kressly's answers to these questions are of great interest to forward looking contractors and engineers.

The progress made in road construction equipment during the past ten years has greatly increased the output with practically the same investment and operating costs. The constant activity on the part of the manufacturers to make their machines more efficient in order to meet the ever-increasing demands of the construction engineer, has been a dominant factor in making the wheels of construction revolve faster. Material producers developed ample supplies of quality road materials to meet the demands to produce the roads in quantity, at low costs. The railroads also contributed in giving preferred service at reasonable rates.

In spite of these achievements highway design and construction fall short of traffic requirements. Splendid progress has been made in designs, quality of concrete and quantity of work produced, but improvement and advancement along these lines must be a constant objective. There must be no inclination to accept present accomplishments as final. Our concern must be not only with the problems of today but those which may arise in the future. The greater percentage of roads of today are not ideal, even in the simple requirements of physical structure. The constrictions of traffic are almost everywhere. Sharp curves, blind intersections and crossings, narrow bridges, narrow pavement widths and traffic-congested streets through cities, prevail generally.

What's Ahead?

Looking into the future, what lies before us?

The unprecedented growth of motor vehicle traffic constantly imposes greater and more important problems upon the highway officials. It is an outstanding demonstration that traffic controls the highway. If the highway is to function efficiently as an agency of transportation, the financing, design and construction of highways must meet new demands. To serve traffic adequately our thoughts must be projected to provide for future requirements.

It is a problem that demands the ability of the leading thinkers and practitioners in highway engineering and administration. For its effective solution there must be a continued and co-ordinated program of highway research embracing all the fields of location, design, construction, operation, maintenance and administration.

Constructive programs of highway improvements, based on traffic and engineering facts, should be planned for development over a period of years, and the highway system improved in accordance with this plan. In building these highways we must follow the one sure guide and that is to build on the basis of serving the traffic economically, but with due consideration for the safety, convenience and comfort of the travelling public.

While our immediate service may require only a two-lane pavement, ultimately we must conceive of four-lane or wider pavements in and adjacent to the more densely populated areas. Our highway structures must be designed to meet future demands with respect to free flow of traffic. The prevailing types of pavement selected to fit future road development must be adequate in strength to carry the loads in accordance with accepted scientific practice. Rights-of-way for secondary roads should not be less than sixty feet in width and for primary roads not less than eighty feet and preferably one hundred feet in width. Each traffic lane should have a width of not less than ten feet; the thickness of pavement not less than six inches on secondary highways, and not less than eight inches on primary highways. The shoulders along the edges of the pavement should be not less than eight feet in width, surfaced with an asphalt-bound gravel or macadam of a thickness of not less than three inches. This will permit parking off the travelled pavement, and also protect the subgrade of the pavement from surface water.

All bridges, viaducts and underpasses should have a clear roadway width of not less than twenty-two feet along two-lane, and not less than forty feet along four-lane paved highways, with walks along each side. The grade of the approaches to these structures should not exceed four per cent, and if on curves, the radius should not be less than six hundred feet, and preferably greater. The clear width between head-walls of culverts should not be less than the width of the pavement, plus twenty feet. Guard fences, guard rails or concrete curbs or walls should be constructed not less than eight feet from the edge of the pavement along heavy fills and the outside edges of highways traversing hilly or mountainous regions. On grades the two-lane pavement should be widened to not less than thirty feet with curbs along each side thereof, to more effectively control the flow of surface water and protect cuts and fills. This also applies to four-lane pavements, except that the width need not be increased, although it is advisable if physical conditions and funds permit.

All curves should be widened and super-elevated, and of a radius which will permit of a safe speed of at least forty miles per hour, except in cities and towns, or in hilly or mountainous regions where impractical on account of physical conditions. Pavements at all important intersecting highways should have an additional width of ten feet on each side for a distance of at least two hundred feet from the boundary lines of such intersecting highways. Such widening also applies to railroad crossings at grade. There is much needed improvement in the location, design and construction of approaches to railroad grade crossings, as well as the design and construction of paving between tracks.

Grade Separation

During the past years grade separation at dangerous places along important highways has increased, and this type of construction should be more extensively used in the future. Separation of grades at intersections of heavily travelled highways must also receive more attention in the future. While the building of grade separation structures involves large expenditures, nevertheless it is warranted since its facilitates the movement of traffic more economically, conveniently and safely. The construction of underpasses across heavily travelled thoroughfares for the use of pedestrians are most necessary structures in modern improvement programs, particularly in the vicinity of schools, public parks and congested areas.

The construction of super-highways connecting densely populated suburban sections, or smaller cities with larger cities to facilitate the movement of traffic should receive serious consideration on the part of highway engineers and administrators. Such a highway should necessarily be constructed so as to eliminate all grade crossings, either with railroads or intersecting highways, with occasional wide approaches thereto from other main highways intersecting it. It should have a width sufficient to accommodate four lanes of traffic and designed and located to permit of a speed of at least forty miles per hour.

It is an outstanding fact that portland cement concrete pavement has been the principal type of construction throughout this country, and it will, without question, continue to occupy first place in future highway transportation development. It has been demonstrated that as a structure it is strong, durable and logically designed and adequately meets traffic demands.

Slab Design

Considering the function of the pavement slab throughout its life, the uniform slab thickness possesses advantages and seems advisable. When a slab of this design through continued use separates into smaller units, it will carry the stresses imposed upon it more effectively, besides facilitating the preparation and construction of the subgrade.

The necessity of expansion joints and the proper spacing thereof is a question concerning which there is considerable discussion. In the majority of pavements recently constructed, expansion joints have been used at more or less regular intervals with varied results. In many instances, even with a spacing of thirty to forty feet, transverse cracks develop with considerable frequency. It is a matter that unquestionably requires further study and research before a general agreement can be reached. In general, however, the formation of cracks can be controlled to a considerable extent by developing concrete of high tensile strength, constructed on a uniformly smooth subgrade.

Dowel spacing along longitudinal joints, unless spaced two feet, or less, on centers, is of questionable value. Even when so spaced, with the edges of adjoining slabs in close contact, and the load at the edge of one, approximately only one-fourth of the load is carried by the adjoining slab. Dowels in transverse joints, with one end firmly embedded in the slab and the other free to move in a sleeve, are practically of no value. There remains much to be done in the matter of efficient joint design. The development of more efficient expansion joint fillers is also most necessary. None of those in use at present are entirely satisfactory.

Concrete Control

While quality control of concrete is steadily increasing each year, there are still all too many improvements constructed under specifications which are out of date and the inspection and construction lamentably inefficient. There is a real need for improvement in the selection and proportioning of concrete materials and construction methods, particularly in some of the cities where paving has not reached the high state of development that characterizes most of the work in states and counties.

There must be a more general appreciation of the fact that quality concrete cannot be produced by any haphazard methods. Careful control must be maintained during every step of the manufacture of concrete from the selection of materials to the final curing. This procedure constitutes the selection of best quality of materials obtainable; proper proportioning of the materials composing the mix; proper grading and proportioning of fine and coarse aggregate, by weight, in accordance with modern scientific methods, so as to produce a dense, workable and uniform concrete, maintaining the lowest water-cement ratio consistent with proper workability; proper mixing, placing and curing. In order that the grading of aggregates may be more effectively controlled, the coarse aggregate should be separated into at least two sizes. General experience also indicates that a more uniform quality of concrete can be produced by using coarse aggregate all of which passes a 1½-inch sieve.

Water measuring devices on concrete mixers can be improved upon as most of them at present are too inaccurate to insure uniformity of concrete. An important bearing on the effective mixing action of concrete is the arranging of the blades, speed, condition of cleanliness and loading of the mixer drum.

As to the laying of pavement it must be emphasized that there is something more than merely mixing the concrete and dumping upon the subgrade. The materials composing it may be of the best quality, scientifically graded and proportioned, properly mixed with the least quantity of water consistent with proper workability, but as soon as the concrete is deposited a separation starts that continues both during and following the tamping period.

On heavy traffic highway intersections, also, the trend is to separate the intersecting grades. This grade separation is in Chicago

Concrete permitted to set in the condition in which it comes from the mixer does not possess the necessary qualities required for pavements. The essential properties must be imparted to the slab after the concrete has been placed, in which time is the important factor. This factor is governed by the conditions obtaining at the time of placing the concrete, such as that of sub-base, atmosphere, time of day and year, and quality and grading of materials. To properly interpret the reactions of concrete to meet these conditions as they occur demands skilled workmanship under trained supervision.

If we are to build better concrete pavements, the above truths must be hammered home to everyone connected with the construction thereof.

Early Strength

In recent years high early strength concrete has been used on a number of construction jobs. Its advantages are real and any extra expense is justified in pavement construction, particularly at intersections, at the end of a section of highway, at bridge approaches, business sections, etc., where early opening of the pavement to traffic is necessary or advisable. Whether the high early strength concrete is obtained by the use of richer mixes, admixtures or special cements, the pavement should not be opened until the concrete has attained a flexural strength of at least five hundred pounds per square inch, determined by actual tests. Concrete of this strength should be secured by an experienced engineer with regular portland cement, using not to exceed 6½ sacks of cement per cubic yard of concrete, in seven days or less, with special cements or admixtures in from one to five days. Whatever the cement used, the production of high early strength concrete should be under the supervision of a skilled engineer, familiar with modern practice in design of concrete mixtures.

When constructing pavements through country sections, half-at-a-time construction is advantageous where adequate detours would cause inconvenience or where detours are not available. If the right-of-way is of sufficient width and physical conditions permit, it is better practice to construct a detour along it or in and along adjacent property if possible. Half-at-a-time construction usually delays the progress of the work and reduces the efficiency of the contractor's organization. This not only adds to the cost of the work in this regard, but there is also an added expense in protecting the work and controlling the flow of traffic.

Size of Contracts

In order to increase the volume of highways constructed during seasonal periods, larger single contracts should be awarded whenever possible. This would enable the contractors to organize their work, personnel and equipment more effectively. This would not only increase production but also reduce costs.

Costs, and particularly loss of time, can be reduced in road and street building operations by improving construction practice and exercising greater care in the award of contracts. Delays caused by breakdowns of equipment, etc., can be reduced considerably by better management on the part of contractors. On the other hand, awarding contracts to persons without the necessary experience and equipment, although in a position financially to handle the work properly, is a common cause of delays, increased costs and inconvenience to the traveling public. The mere fact that a bidder is able to furnish a certified or cashier's check, or surety bond, is in itself not sufficient qualification to justify the award of a contract. Competition of this character is not only unfair to experienced and reputable bidders, but to everyone concerned.

While nearly all contracting agencies are required by law to award to the lowest, regular, responsible bidder, it has its obvious hazards since responsibility is considered too often as meaning financial ability and backing. The definition as to what constitutes responsible bidders must be made clearer and better understood by the awarding officials. The call for proposals should definitely state the conditions that will be imposed on bidders and the qualifications demanded from the standpoint of experience and past performance.

Highway service is not complete unless some thought is given to the comfort and pleasure of the travelers. Rights-of-way should be beautified. Roadside comfort stations should be constructed and maintained. Shade trees planted along the boundary lines of highways would add to the appearance and make it more comfortable for those who travel over them. There is a growing demand for highway lighting. In the future, this should receive more attention and, as is the case with all reasonable public demands, it must be supplied.

Cinderella

(Continued from page 24)

Ruskin's advice was never more needed than today: "The architect's chief means of sublimity are definite shades . . . the Power of Architecture may be said to depend on the quantity (whether measured in space or intenseness) of its shadow." Concrete tracery will provide the high lights and black shadows. In our zones houses need so much window area to admit sufficient light that—so as to provide some restful wall space—the architect is prompted to leave the remaining areas undecorated and only to use the window-hole with its deep shadows and clear outlines as a motif. But are the customary rows of rectangular windows decorative? As concrete adopts any form into which it is poured it is no longer natural or necessary to have vertical or straight contours for wall openings. Wood, brick and steel beams are straight elements and therefore it has been natural to have windows and doors as well as other parts of a design rectangular, as the introduction of curves necessitated extra work. In concrete design curvilinear outlines must become the usual ones as they are more beautiful, and concrete with its reinforcing bars is easily molded into any form.

Concrete tracery will help the architect to once more fulfill his supreme duty—to create poetry and narrate stories. No longer will "Chesterfield" and "Palmolive" be the only eye-attractors. Concrete tracery with its white and black (and possibly color) will also cry forth its message, granted the architect has a message; but the true artist always has a message; see L. N. Tolstoy's "What Is Art," Ruskin's "The Seven Lamps of Architecture," and Upton Sinclair's "Mammonart."

Former generations could not devise such a monumental, effective wall decoration, as stone-tracery lacks the reinforcing bars which, like concrete, can twist and turn into every imaginable shape. We must follow the eternal principles of true art set forth by the ancients and clarified by the Gothic builders, at the same time fully utilizing the marvelous possibilities donated to our generation by reinforced concrete.

The "Planetarium" at Dusseldorf, Germany

The Vincennes church shows other tendencies of the growing ferro-concrete style: constructive arches that soar from the ground to the roof show the tremendous unity of concrete; had they been parabolic instead of pointed this church would be a pure representative of the ferro-concrete style. The frank surface-treatment—painted decorations—has been employed in Europe and America on numerous concrete buildings. But of all the mentioned characteristics concrete tracery promises to be the special glory of the ferro-concrete style.

The tower of the St. Louis church in Villenoble, France. A spire of concrete sculpture, executed by M. Sarrebezolles

Association's Regular Tests Check Up Members' Products

A report of the recent annual meeting of the Bergen County Concrete Products Association brings to light one of the major activities of the association. The latter is composed of 16 of the larger plants in the county and has headquarters at Hackensack, N. J.

Regular tests are made every two months of each member's product by a recognized laboratory by taking the block from the job. This is done by an official of the laboratory together with a representative of the Portland Cement Association. When one of the infrequent failures occurs, opportunity is given to make whatever correction is necessary and another test is made. If the second test does not come up to the standard, the plant is immediately dropped from the association and the building inspectors of the 62 municipalities in the county are notified of the fact. No second failures have been reported.

The officers elected at the annual meeting are as follows: H. W. Bush, president; Chas. Koff, first vice-president; Nicholas Hoffman, second vice-president; Henry Rothenbeck, secretary, Walter Gunby, treasurer.

Performance

Studies of Past Performance and Methods of Improving Performance of Concrete Were Central Subjects at Twenty-fifth Annual Convention of the American Concrete Institute

IT is an interesting coincidence that the twenty-fifth annual convention of the American Concrete Institute is reported in the silver anniversary issue of "Concrete," which also marks ***its*** twenty-fifth year of service to the industry.

If it were possible to select one central thought that was carried through all the sessions, it would be "performance." The attention of the concretor has shifted to durability. Strength alone is no longer his objective. To it has been added another objective — durability under all conditions of exposure that the structure may be called upon to withstand.

Why does some concrete not live up to the high standard of performance that may be expected of it? An examination of some of the earliest concrete structures shed much practical light on this question. Some of the researches reported in the papers presented added more facts. And the discussions, in which experience and opinion were freely exchanged, rounded out and supplemented the helpful information given in the papers themselves. Details regarding these papers and discussions will be found on the following pages.

A Survey of the Industry

The convention program covered many phases of the industry. Construction methods, design, research, architecture, concrete products, central mixing plants—all came in for their share of attention.

New developments in each of these branches were discussed. Existing practices were analyzed and criticized. All effort was directed toward securing additional information that would be helpful to every concretor, no matter what his specialized interest might be.

Approximately 650 delegates — equalling the number at the Philadelphia meeting last year—attended. All the sessions were held at the Book-Cadillac Hotel in Detroit. The convention opened with a get-together luncheon at noon, Tuesday, February 12th, and concluded with the twenty-fifth annual dinner on Thursday evening, February 14th. Between these were morning, afternoon and evening sessions.

Hatt, Hollister and McMillan Honored

During the dinner that closed the sessions three members of the Institute were specially honored for outstanding achievement in their fields. The Leonard C. Wasson medal for "the most meritorious paper" of the 1928 convention was presented to F. R. McMillan, director of research for the Portland Cement Association, for his "Concrete Primer." The Leonard C. Wasson research medal was presented to S. C. Hollister, consulting engineer, for his work in skew arch design as reported in his paper, "The Design and Construction of a Skew Arch," presented at the 1928 convention.

The Henry C. Turner medal was presented to Dr. W. K. Hatt "for pioneer work in reinforced concrete research, for a quarter century of devoted, outstanding and continuous service in developing the knowledge of concrete."

Edward D. Boyer was re-elected president. S. C. Hollister was re-elected vice-president for a two-year term, and Harvey Whipple was re-elected secretary-treasurer of the Institute.

Half Day on Institute Program Reserved for Field Trips

Institute Members Visit Ford Airport and Detroit-Windsor Tunnel

WEDNESDAY morning, Feb. 13th, was set aside in the Institute program for field trips, Though only one trip—to the Ford plant and the Ford airport—was announced in the program, the membership divided itself almost evenly between this trip and one to inspect the construction of the Detroit-Windsor tunnel, now under construction. Both trips started from the Book-Cadillac hotel in the morning and returned to the hotel in time to permit attendance at the afternoon sessions.

The Ford Trip

A feature of the trip to the Ford plant and the airport was the dedication of the concrete runways at the airport in which more than 200 delegates participated. With the dedication of these runways, the first in the United States, Henry Ford became a pioneer in highways for airplanes just as, 20 years ago, as a member of the original Wayne County Road Commission, he was instrumental in pioneering the first concrete roads in America.

During the ceremonies short speeches were delivered by Wm. B. Stout, designer of the Ford-Stout airplanes, and Edward D. Boyer, president of the American Concrete Institute. Mr. Stout said among other things that "ninety per cent of flying is on the ground," emphasizing the importance of having proper runways and airport equipment for taking off and landing. Once in the air, only the plane needs attention.

"Increasing weight of large passenger carrying planes points definitely toward the general adoption of concrete runways," said Mr. Stout. "These big planes must have smooth, hard surfaces for speedy and safe take-offs. The newer planes are being designed especially for use on such runways. I confidently look forward to the general adoption of concrete runways in airports throughout the country."

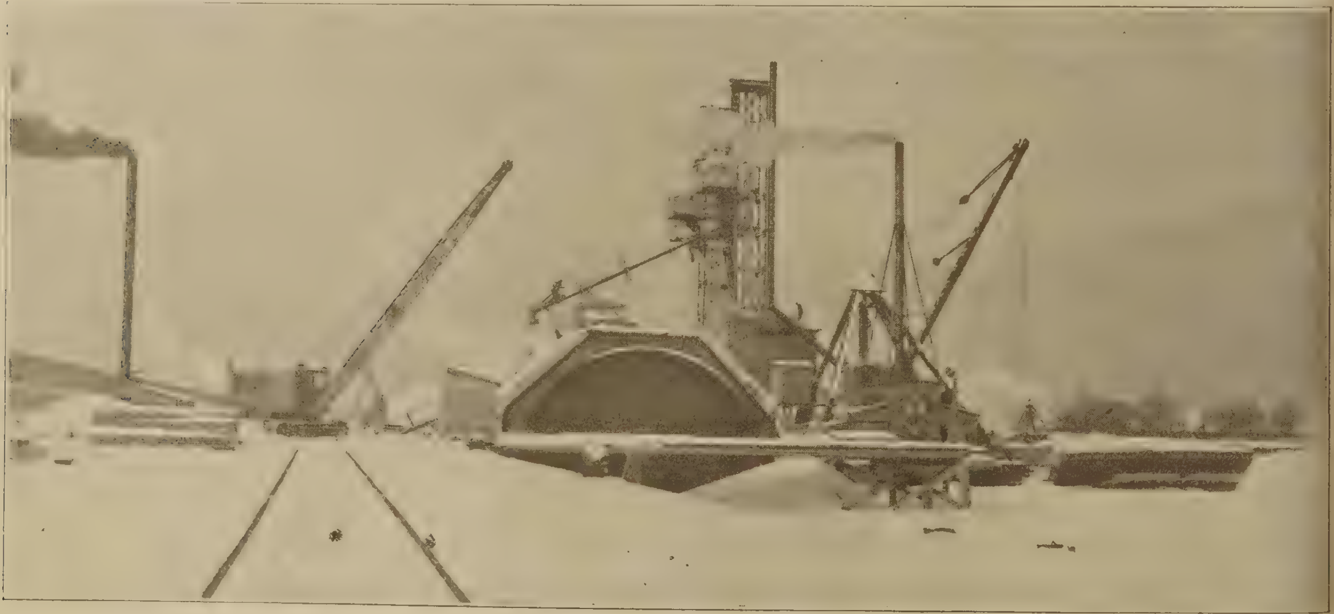
Mr. Boyer, speaking for the Institute, said that it is fitting that this new development in concrete runways should originate in Wayne County, where the first mile of concrete road was put into service in 1909. He commented on the opportunity that now is before concrete engineers in the development of airports and urged members of the Institute to take their part in this new industry.

During the course of the trip the delegates visited the rolling mill of the Ford plant and inspected the world-famous assembly line, where a Ford body frame rapidly evolves into a complete automobile which is driven off under its own power from the farther end of the runway.

Detroit-Windsor Tunnel

A second group of delegates, estimated at about 100, left concurrently to inspect the work of constructing the mile-long vehicular tunnel now being built under the Detroit River to connect the business section of Detroit with the business section of Windsor on the Canadian side. When completed, at the end of 1930, the tunnel will provide a 22 ft. roadway, allowing for one line of traffic in each direction.

Approximately 80,000 cubic yards of concrete will go into the structure. Parsons, Klapp, Brinckerhoff & Douglas, consulting engineers, are acting as engineers for the Detroit & Canada Tunnel Co., who are financing the project. B. R. Value is executive engineer in charge of the project. The general contractors are Porter Brothers & Robert Porter and the Parklap Construction Corporation.



One of the construction views of the Detroit-Windsor tunnel, visited by the American Concrete Institute delegates

A Condition Survey of Concrete Structures

Does *Quality* Concrete Mean *Durable* Concrete?—Three Concrete Engineers Discuss the Old Structures That Were Built Under Their Direction in an Effort to Determine How Construction Methods Affect Durability

PLUNGING directly into the central theme of the convention, the first session on the program dealt with he subject "A Condition Survey of Concrete Structures." The program for this session was arranged with the co-operation of Committee E-6, on Destructive Agents and Protective Treatments, of which A. E. Lindau is chairman and F. R. McMillan, secretary.

The three papers presented, describing early construcion methods, material tests and specifications as they were applied to the construction of some of the first important concrete jobs, all emphasize the fact that when reasonable care was taken, concrete that will endure indefinitely was produced.

With attention shifting so definitely to durability, the construction methods used on these structures are of paricular interest in the light of recent examinations of the condition of the concrete. Wherever construction methods approached those that later years have shown to be necessary for the production of quality concrete, the performance of the concrete has been eminently satisfactory.

Recent examinations of these older structures tend to ndicate that when proper construction precautions are aken, concrete can be produced that may be expected to endure. Those principles of concrete making that produce quality concrete, as it is known today, may after all, also be the determining principles in respect to durability.

A 1907 Dam

The first paper in this group was one presented by H. C. Ash, who in 1905-07 was resident engineer in charge of he construction of the Thompson Dam and Reservoir in northern Minnesota. Mr. Ash described the construction methods used and M. B. Lagaard, of the Portland Cement Association research laboratory, gave an account of the condition of the concrete after 21 years of service when he inspected it in the summer of 1928.

Though nothing was known in 1905 about slump tests, water cement ratio, etc., it is interesting to note the accuate methods used in proportioning the aggregates and egulating the amount of water used. These methods probably seem crude today, but their results demonstrate their value. Nor is the job laboratory entirely a development of the last few years. On the Thompson dam a two-room aboratory was maintained in which cement tests, sand ests and void determinations were made. Careful recrds, giving dates, numbers of sections where concrete was placed, proportions, source of aggregates, car number of cement, etc., were kept.

Aggregates were elevated into overhead bins, fed by ravity into measuring hoppers and then by gravity into 1-yard cubical mixer. Water for the mix was passed hrough a carefully calibrated barrel; a pull of a lever admitted the exact amount wanted, which was shown in pounds on an indicator. Concreting was begun on May 6, 1905. The proportions of materials, as determined for the inspectors, were 21.6 cu. ft. of lake gravel, 8.4 cu. ft. of lake sand, and 5 bags of cement. Water content was determined by trial, the object being to make the concrete of the consistency of thick mush, which by the slump test would show a slump of about 4 inches. Moisture content in the aggregates was not ascertained, but was taken into account by the trial method referred to above. The water added at the mixer varied from about 2.7 to 4.5 gal. per sack, but as the aggregates were taken from the river, they contained considerable moisture. Concrete was rammed into place with 20-lb. wooden rammer, the intention being to produce a concrete that could readily be worked into place and yet leave a reasonably firm surface.

When Mr. Lagaard examined the structure in 1928, his first general impression was that certain portions of it were in excellent condition, while others were in a somewhat advanced state of disintegration. Upon closer examination, however, it was found that much apparent disintegration was in reality a localized incrustation and scale of no structural importance. Underneath these scaly deposits, the concrete was found to be in excellent condition.

Mr. Lagaard says: "The principal objection to placing concrete by the dry-tamp method is the difficulty of obtaining a thorough bond between the successive layers, even though a very high strength and impermeability may be secured in the mass itself. This is very clearly brought out in the examination which showed that bonding planes of successive layers were sharp and marked at the seepage lines. This applies to the successive layers of a few inches in thickness, as well as to the major fill planes marking the end of the day's operations. The greatest seepage took place through the major fill planes and it is immediately below these that the incrustation is thickest."

In concluding his discussion, Mr. Lagaard comments on the careful laboratory control established on this job and expresses the opinion that "the present highly satisfactory conditions of these structures is the reward for the intelligent efforts put forth in the careful study of the materials and control of the placing operations."

Thirty Years' Field Experience with Concrete

Thirty years' of experience in building concrete structures is in itself a point of considerable interest in an industry as young as is the concrete industry. And when the observations of this experience are made available in a paper such as L. W. Walter, inspecting engineer for the Erie Railroad, presented as the second paper in this group, it is reasonable to expect observations that are of value.

Mr. Walter goes back to 1899 in his analysis of his experiences. Even then it was known from tests that concrete of a dry consistency, if well tamped, gave higher strength results than when more water was used in mixing. It was then considered necessary to tamp the concrete until moisture was brought to the surface.

Then came the change "from the drought to the deluge." The method of placing concrete by thorough ramming of dry mixes was tedious. It required special effort and close supervision. Dry concrete was all right for the laboratory, but it was not practical in the field. It was cheaper to handle it when it was wet and it is not surprising that contractors welcomed the trend toward the use of more water.

The history of the first decade of this century is the story of this transition "from the drought to the deluge." The use of very wet concrete was the rule and jobs were put in under all degrees of wetness. The results of the deluge were not long in coming. Before the end of the first half of the second decade, it was apparent that disintegration was starting in much earlier than was the case with the older "rammed" concrete structures. Investigations of a larger number of the older structures showed that the cause would usually always be traced to the use of too wet a mix or to the fact that foreign materials were embedded in the concrete.

Other investigations, made of a large number of concrete arches built during 1907 and 1908, showed that portions of them were in exceptionally good condition, while other portions were beginning to show the effects of disintegration. It was found that this disintegration was entirely limited to the tops and angles at the extreme ends of some of the bench walls which extended beyond the arch rings. Records showed that the concrete in these portions was placed much wetter and that in working the concrete into the forms for the bench walls, some excess water accumulated in the angles and tops and at the ends. The disintegration observed only at these points was attributed to this condition.

Lessons from Concrete Structures in Service

Roderick B. Young, testing engineer for the Hydro-Electric Power Commission of Ontario, opens the last of the papers in this group with the following statement: "Anyone who critically examines a large number of concrete structures in service will be struck with the fact that most of the deterioration found thereon can be classified into a few general types."

These few general types, he says, probably make up over 75 per cent of all the defects found from all causes. They are largely preventable, simply by care and forethought. Proper construction methods, now known to most concretors, will do much to eliminate them. By means of illustrations, he pointed out what these defects are, how they can be recognized and how they can be avoided.

His first type of defect is the very common type where concrete disintegrates at the top of a "lift." When plastic concrete settles and consolidates, water rises to the surface. This action is much more pronounced in wet mixes than in dry mixes. When concrete is placed very wet, a "soupy" mixture collects at the top of the layer or "lift" being deposited. The material at the bottom of the lift loses water to the material at the top with the result that the concrete at the top of the lift is of much poorer quality. This concrete at the top, being porous and weak, is much more susceptible to disintegration and is readily attacked by frost. Mr. Young suggests that a good way to overcome the difficulty caused by this "water gain" is to overflow the forms and then strike off the poorer material that collects at the top. Another method is to increase the quantity of coarse aggregate in the last batches and to place them as dry as they can be handled.

A second type of deterioration often met is deterioration that occurs immediately above a construction joint. Often no attempt is made to provide extra mortar needed when another layer of concrete is placed on the surface of the hardened concrete below. Sometimes, the first concrete deposited in a day's run is partially robbed of its mortar by the amount that sticks to the surfaces of the mixing and conveying equipment. Other factors tending to cause porosity at the beginning of a lift are the practice of dumping concrete into the forms which sometimes causes segregation and that at the beginning of a new layer the forms are deepest so that it is more difficult to puddle the concrete properly.

Various practices that cause segregation are responsible for a third type of deterioration discussed by Mr. Young. Where segregation occurs, there is very frequently evidence of disintegration because the separated mortar is usually porous and of low strength. The concrete that is left behind is usually undersanded and honeycombed. Such instances are most often found in corners or where it is difficult to place concrete, though it may occur anywhere in the structure if the concrete is not properly handled and placed.

Porosity and segregation, says Mr. Young, are most important factors in determining the behavior of concrete in service. They can usually be traced to one of the following causes: Improperly designed mixtures, excess mixing water, undermixing or careless handling or placing. The remedy is simply to follow those principles of producing quality concrete that have been established in recent years.

The last type of deterioration discussed is scaling. This is often caused by over trowelling or by trowelling at the wrong time, or by both. Steel trowelled surfaces are not a success outdoors, says Mr. Young, while floated surfaces seldom scale. Overmanipulation is another cause of scaling. When an overzealous engineer requires concrete next to the forms to be puddled to excess, an outer surface of mortar is built which peels off later. Overmanipulation is as much a construction fault as is no manipulation. And finally, to prevent scaling it is necessary to cure the surface of the concrete properly. Much of the scaling seen could have been prevented if the concrete had been cured.

Mr. Young closes his paper with the statement that: "If the facts brought out in this paper are not new or startling, it should be remembered that most poor concrete is poor because of the neglect of those elementary and well-established rules for its manufacture that should be known to everybody, and not because of any obscure ailments to which it, as a material, is subject. It is not to be inferred by this that all deterioration of concrete is as simple as the cases cited or that concrete does not have obscure ailments, but after having examined many scores of concrete structures of a variety of ages and conditions, the author has been unable to reach any other conclusion than that at least 75 per cent of the concrete in trouble today is so because its makers have permitted a few entirely preventable conditions to occur during its construction.

Discussion

The importance of the subject under discussion was illustrated by the interest in it mainfested in the discussions that followed the presentation of the papers. Though, as Mr. Lindau said in introducing the subject, Committee E-6 is not popular, yet it is a necessary and constructive job that has been undertaken. The committee is interested in obtaining information as to the causes and remedies of deterioration in concrete in order that more knowledge may be gathered regarding those factors that contribute to the durability of concrete.

Dr. Hatt, of Purdue University, contributed an interesting example of durability in concrete. He recently examined a test beam that had been exposed to the weather for 24 years. The beam was made of 1:2:4 reinforced concrete, the steel being placed 1 in. from the surface. In spite of its long exposure to all sorts of weather, it was found that the reinforcing rods were as bright and uncorroded as when they were new, when after 24 years, the concrete surrounding them was chiseled away. The 1 in. of concrete covering them had been impervious enough to prevent rusting.

Another subject brought out in the discussions was the result of compacting concrete in the forms by means of air hammers. It was pointed out that the use of air hammers permitted the placing of drier concrete. It insured the proper placing of concrete in difficult places and resulted in better concrete throughout the structure. In this connection, it was pointed out that excessive vibration was dangerous and the operator must learn how not to use it. This subject was again referred to in a later paper.

Construction—Inspection—Design—Architecture

Second Session Included Variety of Subjects—Long Span Arch Bridge Design in France—Concrete Control—Supervision and Inspection—A New Architectural Style

THE second session of the Institute program, held Tuesday evening, covered a wide range of subjects from the economics of concrete control to a discussion of the question, "Is a specific ferro-concrete style evolving?"

Long Span Arch Bridge

The first paper listed on the program was one by M. Freyssinet of Paris, France, on the subject, "Long Span Arch Bridges in France." M. Freyssinet was not present, but had sent his paper to the Institute for translation from the French. It was given to Mr. Hollister for translation, but did not arrive in time to be presented at this session. It did come by mail the next day, but as Mr. Hollister was not present, there was no one available who was familiar with the paper. Into the breach stepped Arthur R. Lord, who, after only a very short examination of the paper, presented it in abstract and described the slides that illustrated it. It was a feat of no small magnitude to do this and Mr. Lord deserves the congratulations of the Institute for this task.

The bridge described has a total span of 2,130 ft. It is composed of three arches, each of 612 ft. span, center-line to center-line. Two of the arches are already completed and the third is now under construction. Although the design span for each arch is 590 ft., the author considers it a small arch. He says that spans of from 1300 ft. even up to 6000 ft. are not impossible.

The wooden centering, which was moved from arch to arch, is in itself an engineering marvel in the boldness of its design and in its economy. Approximately 26,000 cu. yds. of concrete were placed, the concrete yielding strengths greater than 8,500 lbs. per sq. in. at 90 days. Forms were left in place only 2 days after the last concrete was placed.

Concrete Control Experience

Actual experience records of the dollars and cents value of concrete control are not now as rare as they were only a few years ago. But such experience records usually apply only to a specific job, placed under certain limiting conditions. The paper, "Three and One-Half Years' Experience of the Detroit Edison Company in Concrete Control," presented by A. S. Douglass and J. C. Nelles of that company, is therefore, of particular interest to contractors and engineers. Not only does the account cover a number of years experience, but it shows conclusively that on small jobs as well as on large jobs, the advantages of quality control apply equally.

It is interesting, too, to know that the adoption of quality control methods by the Detroit Edison Company was the result of a previous paper read at the Institute meeting in 1925. At that time two ideas were impressed on the mind of the company's representative: first, that excess water as an ingredient in concrete had no structural value, and second, that the elimination of excess water increased the structural strength of concrete. With these fundamental ideas in mind, it was decided by the authors that they would establish the most thorough system of concrete control which could be made practical. The results of this determination form the subject matter of the paper.

The first quality control job was the construction of a heating plant caisson foundation job, built in 1925. On this job the concrete was designed for a compressive strength of 3,500 lb. per sq. in. Seven sacks of cement were used per cu. yd. of concrete and a slump of 2½ in. was specified. Fifty-two test cylinders were made and the strengths secured, as shown by tests, averaged 3939 lb. per sq. in.

These results looked so encouraging that it was decided to extend control methods to include all the concrete work done by the Detroit Edison Company. During the balance of 1925 control methods were carried out on a dozen other jobs of various sizes. No new equipment was purchased, but water measuring tanks were made in the firm's shops. The results again were found to be of a nature that encouraged the continuation of these methods on all of the concrete work undertaken. After using quality control methods for three and a half years, the authors summarize the advantages secured as follows:

"1—We do get concrete of known minimum strength.

Some excessively low breaks were gotten, but practically all of them were reported by the laboratory as being due to too much large aggregate, or other causes within the cylinder itself. While strength is not the whole story, control methods if properly carried out, will also control the workability, durability, impermeability and placing of the concrete.

"2—We find that it does give a uniform concrete.

"3—We do not have any trouble with laitance.

"4—Enough data have been tabulated to show that there is a real saving in cement without skimping. As the methods of handling aggregates improve, more economies will follow.

"We believe also that it means economy in labor costs. In this connection we again wish to emphasize the fact that quality control does not mean simply analyzing the materials and designing the batch. It means a careful control over all concreting operations, beginning at the source of supply of the materials and ending only when the concrete is properly placed in all parts of the forms, without undue handling; and properly cured.

"It is very noticeable on our jobs that the laborer is fresher at the end of a long run than was the case under the old heart-breaking methods of trying to make the concrete flow into forms out of reach.

"5—It creates a much greater familiarity with the concrete materials and with quantities and yields.

"6—It permits a more intelligent application of the best methods for obtaining high early strength concretes.

"7—It permits a more accurate cost study per cubic yard of concrete before the start of the job and provides a valuable record of the job.

"8—Last, but by no means least, it certainly eliminates about 95 per cent of the worry for the engineer and superintendent."

A point brought out in the discussion was that building material dealers who supply aggregate to contractors are missing a bet by not co-operating with the contractors more fully by supplying him with graded aggregates.

Mr. Douglass estimated that since concrete control had been established on his work, it had saved his company about $38,000 in cement. This was only a by-product of the main objective—quality concrete.

Water Supply Tunnel Construction

Another important job on which quality control played a major part was described in a paper presented by L. G. Lenhardt, assistant engineer in charge of land tunnels for the Department of Water Supply, Detroit. Mr. Lenhardt's paper, entitled "The Concrete Lining of the Water Supply Tunnels of Detroit," described in detail the construction methods used in building 11 miles of land tunnels in which approximately 200,000 cu. yds. of concrete will be placed.

The uncertain soil conditions encountered necessitated careful attention to strength and the severe exposure conditions made durability a matter of prime importance. Careful control methods were adopted with the result that the concrete placed up to the time of the preparation of the paper yielded an average strength of 4014 lbs. per sq. in. at 28 days. An interesting test, made to determine the relation of the concrete in the forms to the concrete at the shaft when pouring sections, showed the following 28 day strengths:

At the mixer	3531 lbs.per sq.in.
At the bottom of the chute	2593 lbs per sq. in.
At the forms	3872 lbs. per sq. in.

One of the construction features on the job was the use of rubber-faced air hammers for vibrating the concrete in the forms and this was the feature around which the discussion of the paper centered. The vibrators used were the conventional sand-rammers as used in foundry practice. Mr. Lenhardt cautioned his hearers that vibrators must be used with care and that the important point in their use consists in knowing when to *stop.* Too much vibrating causes segregation and harms more than it helps. Nevertheless, it was clearly shown that the proper use of vibrators aided materially in securing quality concrete especially under the difficult placing conditions encountered on this job. It was indicated in the discussion that here was a factor that may be extended to a greater number of jobs with benefit.

Detroit has for several years been particularly active in improving the quality of the concrete used in its structures. One of the principal reasons for this progress is the co-operation of J. M. Bischoff, commissioner of buildings and safety engineering for the city of Detroit. His keen interest in improving the quality of the concrete used in the city and in giving publicity to the steadily improving strengths secured, has done much to encourage engineers and contractors to make particular efforts to justify this co-operation.

His methods of supervising concrete work in the city of Detroit and of inspecting the concrete placed were described in his paper, presented under the title, "Supervision and Inspection of Concrete in Relation to Modern Building Construction." By means of daily reports from every job, tests of cylinders taken at regular intervals, and periodic job inspections, Mr. Bischoff keeps in close touch with every concreting operation going on.

After specifications and materials to be used on any job are approved, the city will permit the use of water-cement ratio control, basing its acceptance of the concrete primarily on the results secured from the test cylinders taken. When these show strengths less than 1800 lbs. per sq. in. at 28 days, the concrete is ordered out and must be replaced with new concrete meeting the requirements. In addition, inspections are made on the jobs to assure the department that work is proceeding along the lines of the requirements laid down. At intervals the results of the tests made in the department's laboratory are published and distributed to every one interested. Tests, of course, are available to anyone who has reason to examine them.

One result of this policy of publishing the data secured in the laboratory was to encourage a continual improvement in quality. For instance, comparisons are made of the average strength of concrete placed in the city during the year and compared with similar averages of previous years. Low strengths have almost disappeared and each year the concrete placed shows a greater number of tests that are meeting the strengths aimed at.

A paper of an entirely different type and one that aroused much interest and enthusiasm was given by Dr. Francis S. Onderdonk of the College of Architecture, University of Michigan. Dr. Onderdonk asked the question "Is a Specific Ferro-Concrete Style Evolving?" in the title of his paper and then proceeded to prove that such a new style *is* evolving. To do this he used a number of exceptionally interesting slides and pointed out those characteristics in the use of concrete which, in his opinion, indicate the birth of a new architectural style.

Because of his firm faith in the future of concrete as an architectural material and his enthusiastic and dramatic presentation of the reasons for this belief, he held his audience and imparted to many of them at least a portion of his vision of the part concrete will play in the architecture of the future.

On other pages of this issue will be found an article by Dr. Onderdonk which follows very closely the text of his talk at the Institute.

Research Reports Stress Improved Performance

Volume Changes — Determining Moisture in Sands—Trial Method for Designing Concrete Mixes — Water Tables and Curves for Designing and Estimating Concrete Mixtures—High Early Strength Concrete—Corrosion of Concrete—Tests of Retempered Concrete—Tests of Concrete Using Large Sized Aggregate—Current Researches

As has been the custom in previous Institute meetings, at least one session of the convention was devoted to the general subject of research. In this convention, the papers presented at the Wednesday afternoon session dealt largely with various research problems. The subjects discussed covered a wide range, yet all of them had some relation to the central theme of the convention—improved performance of concrete.

Volume Changes

Introducing their paper on "Volumetric Changes in Portland Cement Mortars and Concretes," R. E. Davis and G. E. Troxell of the University of California said:

"Of late we are beginning to appreciate that the permanency of a concrete structure is dependent upon more than mere strength and rigidity, and that certain other properties, concerning which we have very little quantitative data, are frequently of even greater importance in problems of design. Of these properties, perhaps the one concerning which the need for adequate information is greatest, yet least known, is that possessed of portland cement mortars and concretes of changing their volume, not only during the early period of the hardening process, but thereafter, as variations in moisture conditions occur."

In order to learn more of this characteristic of concrete, a comprehensive series of long time tests was begun and carried forward. It is the results of these tests that are reported in the paper. The tests included studies of the effect of richness of mix, gradation of aggregate, quantity of mixing water, curing conditions, moisture conditions, weathering, admixtures and absorbent forms on the volume changes of the concrete specimens.

A large amount of information was secured and presented in the summary of results. This summary of results occupies nine pages in the report and cannot, therefore, be given here. Only a few of the conclusions are given:

"There is no evidence that lime content affected the shrinkage to an appreciable degree."

"Mortar bars left in absorbent molds expanded slightly for the first two weeks. Thereafter, they shrunk but at a more gradual rate than did the bars with molds removed."

"The shrinkage of bars with non-absorbent molds removed is about 50 per cent greater than the shrinkage of bars with absorbent molds left on."

"The mortar bars made by using plastic cement shrunk more than any of the others."

"Of the 1:2 mortars kept continuously wet, that having the smallest water-cement ratio has the largest expansion."

"Of the 1:2 mortars stored in dry air, the larger water-cement ratio, the larger the resulting contraction."

"For the 1:6.2 mortars, there is no apparent effect of consistency of mix upon either the expansion when stored in water or upon the shrinkage when stored in dry air."

Determining Moisture in Sands

There are many methods of determining moisture in sands and a number of different tests are in use. A quick, accurate method of determining the moisture content is necessary in applying the water-cement ratio method of controlling the quality of concrete placed.

In an effort to compare the speed and accuracy of the various methods in use, W. R. Johnson of the Portland Cement Association research laboratory made a series of tests which were reported in his paper, "Comparison of Methods for Determining Moisture in Sands." In making the tests, Mr. Johnson took samples of sand with known water content and applied the tests, noting the results so far as accuracy and speed were concerned. The following methods were compared:

1. Electric resistance moisture meter.
2. Drying to constant weight in oven.
3. Drying to constant weight with denatured alcohol.
4. Displacement method, using cylindrical container.
5. Displacement method, using A. S. T. M. flask.
6. Specific gravity method, using salt solution hydrometer.

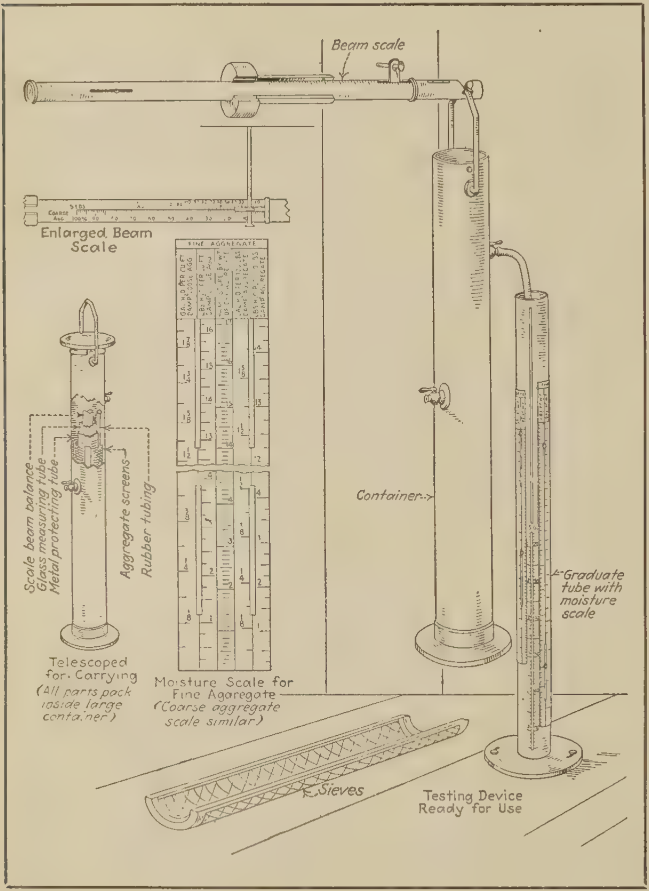
His conclusions were that a comparison of all methods indicated that the best results were obtained with those methods requiring the simplest manipulation. For example, the two drying methods gave the best results. The two displacement methods (cylindrical container and A. S. T. M. flask) ranked next in point of accuracy. The hydrometer method, which ranked last in point of accuracy, required weighing a sample, measuring a definite quantity of salt solution, and reading the hydrometer accurately.

In the discussion that followed, Cloyd M. Chapman defended the A. S. T. M. method, both on the point of accuracy and of speed. He cited some experiments made to determine the time required to make several types of tests and found the flask method speediest.

Designing Concrete Mixtures Mechanically

As quality control of concrete becomes more familiar to the average contractor, it is not to be wondered at that special equipment, aimed at determining some of the data required to design the mix, will be developed. One such piece of equipment, developed by R. E. Robb, professor of civil engineering, Evansville College, Evansville, Ind., was described in the paper, "A Scientific Trial Method for Designing Concrete Mixtures."

Because Professor Robb was not present to present this paper, it was read by title, but Mr. Talbot of the Koehring Company demonstrated the equipment and described the method of using it. An idea of the apparatus and the method of using it may be gained from the accompanying illustration. The apparatus consists of four main parts—a beam scale, a container, a graduate tube and a set of sieves. It was primarily designed to determine moisture content, but can also be used to determine the specific gravity of the material, the absorption of coarse aggregate, and may be used in making colorimetric and sedimentation tests. All of these determinations are made without the use of charts, the values being given directly on the scales.


Beam scale
Enlarged Beam Scale
FINE AGGREGATE
Scale beam balance
Glass measuring tube
Metal protecting tube
Aggregate screens
Rubber tubing
Container
Graduate tube with moisture scale
Telescoped for Carrying (All parts pack inside large container)
Moisture Scale for Fine Aggregate (Coarse aggregate scale similar)
Sieves
Testing Device Ready for Use

Designing Mixtures by Charts and Tables

Another simplified aid in designing concrete mixtures was presented by Herbert J. Gilkey, of the University of Colorado in his paper, "Water Tables and Curves for Use in Designing and Estimating Concrete Mixtures." In this paper, Professor Gilkey's aim was

1. To supply convenient tables and figures covering (a) water-cement-ratio by loose or bulk volume, (b) gallons of water per bag of cement, (c) pounds of water per bag of cement, (d) water-cement ratio by absolute volume, and (e) ratio of water to cement by weight.

2. To include the conversion element so that thought may not be restricted to one unit of measure.

3. To furnish for all units the corresponding estimated strengths according to the well-known Abrams equations.

4. To furnish strength ratios based upon the Abrams curves for added refinement in strength predictions according to the method outlined by Professor Gilkey in the 1928 proceedings of the American Concrete Institute.

A series of tables and charts covering these points were included in the paper.

High Early Strength Concrete

This paper, presented by E. E. Bauer, instructor in civil engineering, University of Illinois, will be reprinted in an early issue of CONCRETE.

Corrosion of Concrete

"Not all concrete deteriorates because of the conditions described and illustrated during the first session of the Institute program," said F. O. Anderegg, of the Mellon Institute of Industrial Research, Pittsburgh, Pa., in introducing his paper, "The Mechanism of Corrosion of Portland Cement Concrete with Special Reference to the Role of Crystal Pressure."

Crystal pressure caused by efflorescent action and by temperature changes is also a common cause of the deterioration of concrete. Crystals formed by such causes as these cause volume changes and pressure as the crystals grow within the concrete. Some effects of crystal formation were shown in a number of slides. An impermeable concrete was shown to be best able to withstand deterioration from the causes described.

Tests of Retempered Concrete

The steady growth in the establishment of central mixing plants and the growing interest in this branch of the concrete industry makes the results of the tests described in the paper presented under the above title of particular interest. The paper covers a series of tests made in the research laboratory of the Portland Cement Association and reported by H. F. Gonnerman and P. M. Woodworth.

The principal conclusions from the tests are:

1. The most striking result was the small loss of compressive strength due to standing for periods up to 6 hours (protected from evaporation) in concrete, remixed without the addition of water. When the mixtures remained plastic and workable, the loss was practically nil. After the concrete ceased to be plastic the strength fell off rapidly.

2. In concrete remixed with the addition of water to restore the original flow after standing for periods up to 6 hours (protected from evaporation) the strength was reduced in accordance with the increase in the water-cement ratio resulting from the added water.

3. When standing unprotected so that the water was lost through evaporation an increase in strength resulted due to the lowered water-cement ratio.

4. Wetting of aggregates 16 hours in advance of mixing the concrete gave about the same strength of concrete as was obtained with dry aggregates using the same amount of mixing water. The workability at all standing periods was materially increased by the use of the wetted aggregate.

5. Premixing the cement and water for 1 minute and allowing the paste to stand for periods up to 6 hours before adding the aggregates resulted in a gradual reduction in the compressive strength as the standing increased, which reduction at the 6 hour period amounted to about 20 per cent of the strength at the 0-hour period. Premixing had little, if any, effect on workability.

6. Increasing the time of mixing from ½ to 10 minutes resulted in an increase in compressive strength both for concrete mixed in the usual manner and for concrete made by premixing the cement and water before adding the aggregate. The percentage increase ranged from 10 to 25 per cent of the strength of the concrete mixed ½ minute.

7. Concrete containing admixtures showed slightly higher compressive strengths than the plain but less flow after each standing period and required the addition of more water to restore the original flow.

In response to a question asked during the discussion, Mr. Gonnerman explained that "workability," as referred to in the paper, meant flow table test which indicated the stiffening of the mix, which, in his opinion really meant workability.

Large Aggregate Concrete

When the Bull Run dam, a unit in the storage project of the Bureau of Water Works, City of Portland, Oregon, was constructed, aggregate was taken from the river below the dam and was screened and recombined so as to produce a uniform grading up to 9½ inches. As the larger sizes of aggregate used were too large for use in the tests cylinders made, the engineers on the dam were confronted with the problem of estimating the strength of the concrete in the dam from test cylinders made with concrete from which all aggregate larger than that passing the 2-inch sieve was eliminated.

This problem gave rise to a series of tests to establish the relationship between the strength of the concrete in the dam and the strength of the concrete used for the test specimens. It is this test and the resulting data that are described in the paper, "Concrete Studies at the Bull Run Dam, City of Portland, Oregon," presented by T. C. Powers of the Bureau of Water Works.

In making these tests, three variables were introduced—(1) the water-cement ratio, (2) the paste content (paste being cement plus water), and (3) the physical condition of the paste at the time of hardening, i. e., its homogeneity.

The results indicated that the physical condition of the paste influenced the permeability as well as the strength of the concrete; that a variable relation existed between the water-cement-strength ratio and the other two variables; and that the modulus of elasticity appears to be greatly influenced by the paste content.

Current Researches in Concrete

The report of Committee E-3 on concrete research was presented by H. F. Gonnerman, chairman of the committee. This was the committee's fourth report and, as has been the case in previous reports, it lists the researches now under way on cement, aggregates, plain concrete and reinforced concrete, adding a list of suggested researches and a list of reference to articles and papers on the subjects covered.

Cast Stone Industry Plans for Future

Meeting of the Association of Cast Stone Manufacturers—A New Name for the Association—The Cast Stone Session of the A. C. I.—The Cast Stone Dinner—A National Advertising Program Adopted

WEDNESDAY, the 13th of February, was cast stone's day at the American Concrete Institute convention. In the forenoon the Association of Cast Stone Manufacturers, formed at Philadelphia last year, held its second annual meeting. In the afternoon a session of the American Concrete Institute was given over almost exclusively to cast stone problems. And in the evening occurred the cast stone dinner, and the cleaning up of those business matters which had been held over from the morning session of the cast stone association.

Three important steps were taken at the morning meeting of the Association of Cast Stone Manufacturers. The name of the association was changed to the Cast Stone Institute, the officers of the previous year were re-elected for the coming year, and definite authority was given to the officers and directors to work out a constructive program for the next twelve months.

The president's report indicated the association to be in good condition, both from the standpoint of internal organization and finances. Means were discussed for increasing the funds of the Institute in order to provide for advertising and research work to further the sale of cast stone. The work of the various committees during the past year was approved, and the by-laws prepared by the officers accepted and voted in force.

The meeting was distinguished by a very marked spirit of co-operation, and an obvious determination to make the Cast Stone Institute an important element in the growth of the industry.

The A. C. I. Cast Stone Session

The afternoon session of the American Concrete Institute was attended by practically every cast stone man present at the convention. A number of important papers were read and considered, and several important specifications passed upon. A summary of the session follows:

The Development and Use of Commercial Cast Stone

The paper presented by L. A. Falco, president, Decorative Stone Company, New Haven, Conn., under this title was largely historical, but included some suggestions for the development of a more definitely recognized cast stone technique which would help secure for cast stone its proper place in the construction field as a material of recognized superiority.

The Physical Properties of Commercial Cast Stone

John Tucker, Jr., and G. W. Walker, U. S. Bureau of Standards, Washington, D. C., talked on this subject, giving a rather complete report of the various tests made at the Bureau of Standards to determine the characteristics of a number of samples of cast stone submitted by various manufacturers throughout the country. It provided much of the material used by Committee P-3 in working out their tentative specifications for cast stone.

Testing Concrete for Absorption

This was the title of a paper by Fred Weigel, Southern

Cement Products Co., Knoxville, Tenn. It will be reprinted in an early issue of CONCRETE.

The Limitations of the Absorption Tests for Concrete Products

Raymond Wilson, associate chemist, Research Laboratory, Portland Cement Association, Chicago, spoke on this subject. These last two papers resulted in a very considerable amount of discussion. The general concensus of opinion seemed to be that the absorption test was inaccurate, uncertain, and rather indefinite as to meaning, but that in spite of these inherent weaknesses, the test should be retained as the only available measure for the relative density of concrete products.

Proposed Specifications for Cast Stone

The essential points of these specifications are a minimum compressive strength of 5000 pounds per square inch, and an absorption of not less than 3 per cent nor more than 7 per cent. Although there was some sentiment for dispensing with the absorption test as part of the specifications, the specifications were carried as proposed.

The Effect of Curing Temperatures

R. A. Foley, general manager, Superior Products Company, Detroit, told of his experiments in the curing of concrete pipe, which seemed to indicate the following:

1. Tensile strength in concrete is more affected by curing conditions than is compressive strength.
2. One hundred and ten degrees Fahrenheit is apparently the highest point at which steam curing is an advantage.
3. One hundred and fifty degree Fahrenheit results in lower strengths than obtained with curing at 110 degrees Fahrenheit.
4. Forty-eight to 60 hours constitutes the economic maximum time for curing.
5. Concrete pipe are extremely sensitive to curing conditions, and pipe manufacturers should study carefully their curing problems if they desire to produce pipe economically.

The report of Committee P-6, concrete products plant operation, Benjamin Wilk, chairman, E. G. Lantz, secretary. While the tests reported by this committee were not sufficiently extensive to allow definite conclusions on all points involved, their studies do seem to indicate quite conclusively that about 7 minutes is the maximum time of mixing desirable in products plants. During a discussion of the report it was brought out that dry mixing has apparently little or no effect upon the resulting concrete.

Proposed Revised Specifications for Concrete Brick

Report of Committee P-1, standard concrete building units, E. G. Lantz, secretary. These new specifications were passed with but little discussion. The tentative specifications for manhole block, and for concrete block and tile, were also passed from tentative to standard.

Proposed (Joint Committee) Specifications, Reinforced Concrete Culvert Pipe

Committee J-2, B. S. Pease, chairman. These specifications were passed without discussion.

The Cast Stone Banquet

In the evening occurred the annual banquet of the Cast Stone Institute. At this dinner the Institute was addressed by three men, John N. Vandevrees of the United States Chamber of Commerce, George J. Eyrick, Jr., of Smith, Hinchman & Grylls, and by Austin Bement, of the advertising agency of that name.

Mr. Vandevrees discussed at some length the advantages of trade associations, and the invaluable work which such associations perform for their members. The many examples which he cited of association accomplishments helped to make more obvious to those present the opportunities which are available to the Cast Stone Institute.

Mr. Eyrick congratulated the Institute upon having helped create a standard specification for its product, and suggested some ways in which that specification might be further developed to advantage.

The last speaker of the evening, Mr. Bement, outlined a definite program of advertising which he suggested as suitable for the purposes of the Cast Stone Institute. Speaking in very definite terms, he made quite plain to those present just what could and could not be done with the means at the Institute's disposal.

An Advertising Program Adopted

Following the addresses by these three speakers the Cast Stone Institute convened in business session to consider the advertising proposal made by Mr. Bement. After a very careful discussion of the whole problem, it was decided to adopt the program suggested, and an equitable schedule of graduated dues was worked out to raise the necessary funds. The meeting closed with a general feeling of good fellowship and satisfaction with having worked out a definite co-operative program in the face of a number of difficulties.

Those who are engaged in the cast stone industry today have reason to be a little more than ordinarily proud of their industry. Starting with a first attempt at co-operation only one year ago, it has today reached the point where manufacturers with distinctly conflicting interests are able to discuss their problems dispassionately, and agree upon what terms they can co-operate. It has laid out a definite program for research and sales promotion, and willingly taxed itself to raise the funds for such work. It has shown the widest possible confidence in the officers of its organization, trusting them fully and willingly with its problems.

The Cast Stone Institute is to be congratulated upon its record—and upon the example it has set for other groups in the industry.

Construction Cost Average for 1928 High

Construction costs during 1928 averaged slightly less than double the figure recorded for 1913, according to D. A. Garber, general manager, Associated General Contractors of America, with headquarters at Washington, D. C.

The year closed with costs holding the position they attained last October, following a series of rises that began in June. Despite the increases noted during the midsummer and early autumn months, however, the average for the entire year was slightly below the corresponding average registered for 1927.

A feature of construction costs in 1928 was the remarkable stabilization of wages which prevailed. Only twice during the year did the average of wages change its position, a slight decline in June being balanced by a corresponding rise in September.

Increases in prices commanded by basic construction materials were responsible for the rises in the general cost average, the month-by-month statistics indicate. The average of material prices dropped in March but rose in June, August, September and October.

No changes in either the wage average or the average of material prices was noted during the last three months of 1928.

Development of Specifications for Reinforced Concrete

Specifications for Centrally Mixed Concrete—Confusion of Specifications for Aggregates—Specifications for the Small Job—Continuity in Reinforced Concrete Design—Design of Reinforced Concrete Slabs—An Absolute Basis of Proportioning Concrete and Its Economy

SPECIFICATIONS for concrete have a very important effect on the quality of the concrete placed. Unless specifications develop in accordance with the increasing knowledge of those factors that control the quality of concrete, much of the progress that might be attained is lost. In recent years there has been a very decided trend toward a revision of the old type of specification. Rather than tying the contractor down to an infinity of more or less unimportant detailed requirements of *how* the work is to be done, the newer specifications concern themselves to a greater extent with *what* is desired. In a greater degree than before, they permit the contractor to select his methods, holding him responsible for the results. The trend toward the more general adoption of a strength specification for concrete is an example.

Some of the points influencing the recent changes in concrete specifications and some recommendations for still further improving them are covered in the first papers presented in this session. Another group of papers considers some design problems and the session ends with another paper on concrete quality control.

An Architect's Viewpoint on Specifications

How Smith, Hinchman & Grylls, engineers and architects of Detroit, revised their specifications to take advantage of the newer knowledge about concrete was told in a paper read by George J. Eyrick, Jr., specification writer for this organization.

"It was largely due to the work of the Joint Committee on standard specifications and through the work of research men whose work has been published in the proceedings of technical societies and in the technical press, that we began to seriously consider a complete revision of our concrete specifications," says Mr. Eyrick.

Early Specifications

The early specifications used by this organization were a rewrite of the "1914 Report" of the Joint Committee, modified as necessary to meet the various job requirements. When work on the Greater Penobscot Building and the Union Trust Building was started, a new specification was written in which account was taken of the newer requirements. The grading of both fine and coarse aggregate were included, as was also the amounts of water to be used with each sack of cement. Field laboratories were required on all large building projects equipped with a complete set of sieves, a sieve shaker and time switch, a platform scale and a breaking machine of 200,000-lb. capacity. The present specification also calls for "six test cylinders for each pouring and class of concrete" by means of which the strength of the resulting concrete is checked with the requirements.

The results of these changes in specifications have been very favorable, both from the point of view of quality and economy. Contractors are co-operating and clients are benefiting as a result.

Confusion of Specifications for Aggregates

The aggregate producer and the material man's point of view was presented in the next paper, read by L. E. Williams, of the State Concrete Materials Company, Detroit. His object was to point out the diversity of aggregates called for in any given territory. Consider, for instance, such terms as flat, sharp, fifty-fifty, granite and torpedo as applied to sand. Just what do they mean?

Suggested Standardization

Concrete aggregate producers have viewed with longing, if not with envy, the results which are being obtained in other industries in the matter of standardization, says Mr. Williams. He suggests that: "Concrete of all classes should not require more than two specifications for fine aggregates; one, written as broadly as is consistent with the requirements for mass work, heavy structures, and the ordinary run of concrete; and one, with possibly closer limits, for work where either particular surface finish or exceptional workability are required. Coarse aggregates of three types, or at the most four, should fill all requirements. One should cover mass work, paving, etc., one for ordinary reinforced concrete construction, and one for fireproofing or very close reinforcement, with possibly a fourth for work of a very special character.

"All of these specifications should be written not only with reference to the technical requirements of the work, but also with due consideration for the practical limits of commercial production.

"On construction requiring very close control it would be distinctly advantageous to ship coarse aggregate in two or more sizes and combine them in batches at the mixer.

"Before consistent and dependable results can be obtained there must be a co-ordination of specifications and a closer co-operation between the specification writer and the producer of aggregates."

Proposed Purchase Specifications

Almost as if in answer to Mr. Williams' suggestion, the next paper presented was the report of Committee E-5 on aggregates, in which a revised purchase specification for concrete aggregates is proposed. The specification has been changed so as to be identical with the A. S. T. M. specification, and though there was some question regarding the paragraph on mortar strength, the committee submitted the report for adoption as a tentative standard. The mortar strength clauses were incorporated as a means of defining aggregate that does not conform in grading and size to the other requirements, but which can be accepted on the basis of mortar strength. Until some better means of taking care of this matter has been found, it will be retained. The convention voted to approve the specification as a tentative standard.

Specifications for Particular Uses

A paper, presented by P. J. Freeman under the title, "Some Considerations for Specifications for Centrally Mixed Concrete," is printed in full on other pages in this issue.

Another paper, by S. C. Hollister, "Specifications for the Small Job," was read by title and will be incorporated in the Institute proceedings.

Continuity as a Factor in Design

In introducing his paper, "Continuity as a Factor in Reinforced Concrete Design," Hardy Cross, professor of structural engineering, University of Illinois, said:

"The purpose of this paper is to explain a rapid and accurate approximate method for analyzing continuous girders and frames of reinforced concrete for bending moments, shears, and reactions and to bring together certain questions and considerations which bear on the interpretation of such analysis."

The paper as preprinted, covered 40 pages of text, charts and tables. It was presented in abstract by Professor Cross in the sincere, forceful manner that characterizes his addresses. Its central ideas can best be summarized by quoting in full the conclusions given at the end of the paper:

"A sufficiently accurate approximate analysis may be quickly made for any continuous frame including the effects of haunches and columns. This should give maximum curves of moment and maximum end shears.

"In short span construction where torsional elements play a large part, it is doubtful whether moments can be determined with great precision. In general the tendency of the continuity of the whole structure is to increase the loads due to the continuity of connecting members and also to make the span act as an isolated fixed end beam because of torsion.

"Determination of the longitudinal steel required is quite satisfactory. Problems of bond and of web reinforcement are, however, less clear. It is not possible to directly apply, without further investigation, the curve of maximum shears to determine bond by the bond formula nor to determine anchorage.

"Stresses in columns due to continuity are quite uncertain. It is quite doubtful whether the theory of continuity in such a case will give values closely enough in accordance with the facts to justify the elaborate theories applied in the analysis of such columns.

"Continuous structures are not necessarily more economical than are structures which are not continuous.

"If a structure is continuous, as nearly all concrete structures are, it is essential to consider this continuity in the design.

"Continuous structures will not as a general rule deflect less under load than those which are not continuous, provided the continuous structures are economically designed. This rule may or may not have application in concrete construction depending upon whether there is necessarily a large amount of idle material."

Design of Reinforced Concrete Slabs

Another valuable design paper, presented under the above title by Joseph A. Wise, assistant professor of structural engineering, University of Minnesota, completed the design papers presented at this session. His theme was that reinforced concrete slabs possess an element of strength that is often neglected in design, resulting in wasteful practices. This neglected element of strength is what he terms "plate strength," which is neglected when concrete slabs are analyzed as though they were composed as separate beams. A method of designing concrete slabs in which this "plate strength" element is taken into account was given in detail in Professor Wise's paper.

Proportioning Concrete for Economy

Readers of CONCRETE are already somewhat familiar with the work that Joseph A. Kitts, consulting concrete technologist, is doing in the way of considering the cost angle in designing concrete mixes. In his paper, presented before the American Concrete Institute under the title, "The Absolute Basis of Proportioning Concrete and Its Economy," Mr. Kitts describes the method of proportioning that he has used since 1924 on projects using an aggregate of 1,000,000 cubic yards of concrete. The method has proven thoroughly practical and has effected large economies, and is particularly valuable as a basis of exact and comprehensive concrete research.

Pipe Association Meeting Follows A. C. I.

The week of February 11, was "concrete week" in Detroit. During it were held the meetings of the National Concrete Products Association, the American Concrete Institute, and the American Concrete Pipe Association. The pipe manufacturers gathered from all parts of the nation for their particular meeting on February 14th and 15th.

Registration of delegates to the Pipe Association meeting began on February 14th, at 9:30 o'clock, at the Book-Cadillac Hotel. At 10 o'clock, the first session of the convention opened with the annual address of the president, R. A. Foley. Mr. Foley reviewed the past work of the association and outlined the program for future activities. He also reported the results of the Executive Committee's meeting which was held on the afternoon of February 13th.

Following Mr. Foley's address, the report of the secretary-treasurer, M. W. Loving, was presented. Then came reports of the committees on Constitution and By-Laws, Membership, Traffic, and Convention Arrangements. A get-together luncheon, given by the Detroit manufacturers, followed the morning session.

Merchandising

During the afternoon session, at which Howard Schurmann, president of the Independent Concrete Pipe Company, Indianapolis, presided, Asa E. Phillips, consulting engineer, presented a progress report of the national sewer survey which was conducted during 1928. This was followed by a round-table discussion of sales and promotional methods as used by the various pipe manufacturers.

The Friday morning session was devoted to the subject of "traffic." C. H. Bullen, chairman of the committee, presided. Considerable study has been given to the subject of traffic during the past year, and the results of this study, together with suggestions from other traffic men, were considered at this session, for the purpose of formulating plans for future activities.

The use of concrete pipe in municipalities and in highway construction was the subject for the closing session of the association. Captain C. Harrington, chief engineer, Bureau of Governmental Research, Detroit, delivered an address on "The City of Detroit, Past, Present and Future." Officials of state and county highway departments followed this address with a discussion of highway building problems, especially as they referred to the use of concrete pipe.

Standards of Performance of Concretes for Various Uses

A Series of Papers on the Characteristics of Concrete for Various Conditions of Exposure—In Sea Water—In Alkali Ground Water — For Pavements — For Industrial Floors—For Masonry Units—For Stucco—For Dwelling Houses

THE last technical session of the Institute convention reverted to the theme topic of the entire meeting—performance. During this session nine papers, each dealing with a different type of structure subjected to different types of exposure or wear, were presented. In each, specific recommendations were made for improving the concrete so as to gain the maximum of service from it.

In introducing the subject, E. D. Boyer, chairman of the session and president of the Institute, commented on the fact that he, personally, knew of hundreds of cases where concrete under a wide variation in service and exposure conditions had rendered service of the highest satisfaction and that sometime, if he lived long enough, he was going to write and present a paper that would emphasize the satisfactory performance that these structures have given. Whether he thought that the program emphasized the need for care in construction to such an extent that the impression might be gained that all concrete was in a greater or lesser state of deterioration, is not known. Certain it is that in this meeting there was very little patting on the back. Every effort was made to get at the central idea—that concrete *must* be produced that will withstand wear and weather.

As was shown in some of the earlier sessions, it was pretty well established that when concrete of the type which we have come to know as "quality" concrete is placed, there was every reason why it could be expected to render long and satisfactory service under severe exposure conditions. The effort was rather to locate those improper construction practices which in some instances produce concrete that will not match the standard of durability which can rightfully be expected from this material.

Though the papers were not presented in the sequence shown in the program, and though the subjects in this group were not all covered in the morning session, they are reported here in the order in which they appeared on the program and in a complete group.

In Sea Water

H. E. Squire, assistant harbor engineer, Board of State Harbor Commissioners, San Francisco, discussed the performance of concrete exposed to the accelerated weathering conditions usually found in marine structures. His conclusions, resulting from long experience and study of concrete under these conditions are as follows:

". . . It may be stated with assurance that the methods of ordinary good practice will produce a concrete so durable in sea water that for the engineer's purpose it may be considered permanent. Durability is obtained not through the chemical inertness of the cement itself but through the mechanical resistance of the concrete to the circulation of sea water in the interior mass. It is possible that little more can be effected by the engineering technologist through his proportioning and manipulation of the concrete, but it is probable that much may be accomplished by the chemist in producing a cement less susceptible to chemical change in contact with sulphate solutions, or of a blended cement in which ingredients like ground puzzolan are introduced to react with and render inert ingredients affected by sea water. But in view of the satisfactory results achieved with the present standardized portland cement, such development will be advantageous only in allowing the use of poorer mixes and in offsetting the results of poor workmanship.

"The same assurance cannot be expressed in regard to the durability of reinforced concrete. A great deal remains to be effected by the engineer; first, in frankly acknowledging the limitations of concrete in protecting steel exposed to the electrolytes of the sea, and then in educating owners to the necessity of maintaining these structures by periodic painting and occasional repairs. . . . Maintenance by painting with impervious coatings offers an inexpensive and reliable means of prolonging indefinitely the life of reinforced structures exposed to sea water. Progress in constructing more resistant reinforced structures must come in large part from the metallurgist in developing non-corrosive coatings for the steel. The galvanizing of reinforcement is being justified with increased use, and the development on a commercial scale of metallic coatings gives more promise of solving the problem than the possibility of securing absolute protection from the concrete itself."

In Alkali Ground Waters

In discussing the performance of concrete exposed to alkali ground waters, C. J. Mackenzie, of the University of Saskatchewan, listed some of the more recent findings of the past few years in this regard. These are:

1—Actions of sodium sulphate and magnesium sulphate, which formerly were supposed to be similar, differ materially and affect different cements in different ways.

2—Concretes and mortars made from portland cements from different mills and from different aggregates may differ widely in their stability in alkali waters.

3—Strength tests are not indicative of the relative sulphate resistances of cements.

4—High alumina cements are very resistant to attack by magnesium sulphate and are more resistant to sodium sulphate than most portlands, but they are quite easily attacked by sodium carbonate, which is present in many localities in the West in the form of "black alkali."

5—It has been found that, if even a lean concrete made from a cement of low natural resistance to alkali be steam-treated at temperatures not lower than 212 deg. F. for a sufficient length of time, it can be made absolutely immune to attack by sodium sulphate and very resistant to attack from magnesium sulphate. It was also found that if the temperature be less than 212 deg. F. such resistance is not developed and under certain conditions the resulting product may be even less resistant.

With these conclusions established, the problem of mass work in concrete still remains, where steam treating is impossible. In such cases certain protective precautions will be found valuable. First, the ground water should be carefully analyzed to determine just what salts are present and in what proportion and concentration. Second, a cement should be selected that shows a high resistance to that type of water. Third, all the well-known steps should be taken to obtain a rich, strong, impermeable concrete. Such measures will usually be effective if the sulphate concentration of the ground water is not greater than 0.5 per cent. If greater concentrations are found, the concrete must be protected by a membrane waterproofing or the water must be diverted from contact with the concrete.

In Concrete Pavements

"Taking everything into consideration, pavements are called upon to resist probably not only as severe but also as great a variety of destructive forces as any type of structure in which this versatile engineering material—concrete—is used," said F. H. Jackson, senior engineer of tests, U. S. Bureau of Public Roads, in introducing his paper, "Special Characteristics of Concrete for Pavements."

Pavements must resist two types of destructive forces; first, the forces due to natural causes, such as variations in temperature, moisture, etc.; and second, the forces due to traffic loads. In order to overcome, in a measure, the results from these forces, the U. S. Bureau of Public Roads has formulated certain principles which will result in more uniform quality and will also reduce the cost to the public. These recommendations are:

1—Abandonment of volumetric proportioning of aggregates and the adoption of proportioning by weight. Inundation will be recognized as a permissible alternate method for fine aggregate, but weighing will be preferred.

2—Maintenance of the lowest water-cement ratio which, with the type, grading and proportions of aggregate and methods of finishing employed, will produce a workable, dense and uniform concrete.

3—The scientific grading of coarse aggregate by combination of the separated sizes in each batch in the proportions which will produce the maximum practical density.

4—The abandonment of hand finishing methods.

In Industrial Concrete Floors

John G. Ahlers and his associates, J. J. Lindon and M. F. Bird reported a series of tests carried out on nine different types of industrial cement floor finishes to determine the comparative wearing strengths of each. All of the finishes were different and it was hoped to determine which type of finish had sufficient resistance to wear, and still was sufficiently low in cost to warrant special consideration.

Panels 1 and 3 were proprietary finishes, No. 1 having been placed by the Kahlman Floor Company, Inc., and No. 3 by the American Betonac Company. No. 2 consisted of a 1-in. topping composed of 1 part of tested portland cement and 2 parts of grits (no sand being used) and placed monolithic with the slab. Panel No. 4 consisted of a 1-in. topping proportioned 1 part cement, 1 part sand and 1 part grit, and placed monolithic with the slab. Panel No. 5 consisted of a 1-in. topping of 1 part cement, 1 part sand and 1 part grit. Thirty pounds of metallic hardener per 100 sq. ft. were floated into the surface and then trowelled. Panel No. 6 consisted of the same proportions, but no hardener was used. Panel No. 7 consisted of the slab itself without topping, and finished with 30 lbs. of metallic hardener per 100 sq. ft. Panel No. 8 was the same as No. 7, except that 40 lbs. of metallic hardener were used. Panel No. 9 consisted of the slab itself containing a quart of calcium chloride solution per bag of cement, rodded off, and finished with 30 lbs. of metallic hardener per 100 sq. ft. Abrasion tests were made with a rotary machine, the wheels set to describe circles of 36, 40, 44, and 48 in. in diameter.

The outstanding result of the tests seems to be that all the slabs gave excellent resistance to extreme abrasion and all can be said to be suitable for industrial purposes. Costs varied from $0.76 to $1.07 per sq. ft. of finish.

Concrete Masonry Units

E. Grant Lantz, secretary of Committee P-1, contributed the section on concrete masonry units. His paper emphasized those properties of concrete masonry other than strength that have aided in the general acceptance of this material. Strength is important, but does not overshadow the qualities mentioned and described, namely: Temperature insulation, fire resistance, sound insulation, weight, wall efficiency, bonding power and permanence.

Bill Allan, of the Portland Cement Association, read his paper on the performance of concrete stucco and analyzed that material from the standpoint of permanency, water-tightness, freedom from discoloration, windproofness and fire resistance. He incorporated a large amount of helpful advice on construction and application methods.

"Livability of Concrete Houses" was the subject of the paper written by S. C. Hollister and read by title, because of Mr. Hollister's absence. The problem was to secure concrete houses that would be free from dampness from beneath, from rain or snow from above, and from the elements driven against the sides.

In order to secure houses with these qualities, it is necessary to:

1—Prevent moisture from rising from the foundations.

2—Prevent moisture absorption through the walls and from the walls into the floor and roof slabs. How these can be secured was the topic of the paper.

Papers covering the other two phases of the subject—"For Reinforced Concrete Buildings," by N. L. Doe of the Turner Construction Company, and "For Fire Resistance," by N. D. Mitchell, U. S. Bureau of Standards, were also read by title, and, as they were not preprinted, they cannot be reported.

Monolithic Manholes

Monolithic reinforced concrete manholes as shown in the illustration were recently completed by the George C. Bartram Company, for the city of Buffalo, New York. They have an inside diameter of 8 ft. 6 in., a length of 14 ft., and weigh 35 tons each.

Concrete Products Association Plans Extended Activities

Annual Meeting Precedes A. C. I. Gathering—Discuss Plans for Making National Association a More Active Influence in the Industry—Co-operation of All Products Manufacturers Needed — Papers Analyze Present and Future Needs

WHETHER or not a national concrete products association will continue to function depends entirely upon the readiness of the better class of concrete products manufacturers to get behind such an organization. If the sum-total of the activities of a national association is simply to hold an annual convention in conjunction with the American Concrete Institute meeting, there will hardly be enough interest in the organization to keep it a going concern.

Opportunities—yes, crying needs—for an actively functioning organization there are many. Yet, just to come together once a year for a perfunctory gathering is far from meeting the co-operative needs of an industry that is growing as rapidly in volume and in new developments as is the concrete products industry. Almost overnight tremendous changes are taking place that are capable of helping or hindering the development of the industry. And at present there is no national organization—or there wasn't until this meeting—that is equipped to handle these problems for the best interests of every manufacturer.

A New Plan Adopted

That this thought was in the minds of many who attended the last annual convention held at the Book-Cadillac hotel in Detroit, February 11th and 12th, is shown by the action taken at the association's business meeting in its concluding session. It was then decided that definite determined effort be made to put the national concrete products association on an active and constructively helpful basis.

Could this be done? was the question raised by some who attended. Are there 500 products manufacturers in the United States who are far-sighted enough and progressive enough to support an institution that can do much to solve their most pressing problems?

Certainly recent experience with the national association does not allay any such fear. Only a comparatively few manufacturers have interested themselves actively in national association affairs.

Perhaps this was due to the fact that heretofore the products association had no definite objective—no plan of operation for the immediate benefit of its members.

That can no longer be a reason for non-support, for at this meeting a definite plan of action was mapped out. It is for American concrete products manufacturers to say whether or not this plan can be put into operation. Its success depends upon co-operation.

Products manufacturers have too long depended on outside help. Have they lost the will or the nerve to act for themselves? Are they big enough as a group to act co-operatively for their own benefit? The month just ahead will answer these questions.

Officers Hold Over

It was moved and passed that a co-operative advertising campaign be undertaken by the national concrete products association. To finance this campaign, it was decided that all products manufacturers producing 250,000 block per year be asked to contribute $100.00 annually and plants producing less than this $50.00 annually. It must be admitted that this is an extremely small amount when considered in the light of the cost per block. It is only necessary to compare these dues with those voted by the cast stone manufacturers to see that this is a small sum for carrying on a program such as will be required. It was planned that with the first sums to be paid in, the association would hire a paid secretary to carry on the work. In the meantime, the work will be done by volunteers.

With this as a beginning, a wide future opens up before the concrete products association. You, as a progressive products manufacturer, are invited to get behind this real effort to put the national association over in a big way.

President's Address

The convention was opened by an address delivered by Newton D. Benson, past and incoming president of the association. He stressed the changing conditions that the products manufacturer will be, and is, being called upon to meet. He pointed out six principal lines along which progress must be made:

1—The development of a unit that meets the need of the buyer in every respect, so far as weight, shape and quality is concerned.

2—Better service. The products manufacturer must be prepared to supply more than just the standard sizes of block. To a certain extent, he must co-operate with the builder in making units of special design. He must also be prepared to extend his ideas of credit, by increasing the amounts and giving the buyer a longer time to meet his obligations.

3—Through better methods of testing, better manufacturing methods must be arrived at, especially from the standpoint of quality control and economy.

4—Plant layout must be improved. Truly automatic products plants, in which at present unbelievable low labor costs are attained will be developed.

5—More business-like methods of running the business must be adopted by products manufacturers in general. Much can be learned from studying the methods used by business men in other industries.

6—And last, but not least, the products manufacturer must face the coming year with more courage! Every products manufacturer can write his own elaboration of this statement.

A Review of 1928

Though Bill Allan's subject was "What 1928 Brought Forth for the Concrete Products Industry," the subject matter of his talk was more along the lines of what 1929 must bring if the products industry is to realize its possibilities.

He started with an analysis of the 1928 production figures, similar to those reported in the account of the Wisconsin meeting published in last month's issue. With these as a basis, he summarized the possible developments that lay ahead. If all the volume of work in which concrete building units might be used were converted to the standard brick unit, there would be approximately 16 billion brick used annually. Of this total potential market, the concrete products industry supplies units roughly equivalent to about 4 billion brick—only one fourth of the total. A large increase in building volume cannot reasonably be expected in the years immediately ahead. The need, therefore is to get a larger percentage of this already existing total possible market. It is a fact, says Bill Allan, that if all the products plants now in existence would operate at 100 per cent efficiency, they could supply equivalent to 20 billion brick.

This brought up the subject of merchandising and greater plant efficiency and a lot of related subjects. Bill spoke for some time, each minute hammering home some angle that the products manufacturer must consider and act upon in the light of the fast moving developments that are now before him.

What of 1929?

No products association program is complete without a talk from "Spec" Collins, and though he said that Bill Allan had stolen all of his thunder, "Spec" got under way in his usual style and put over some facts that could not be ignored. His theme, also, was the changing conditions in the industry and the need to be on the alert or be left behind in the rush. Especially must the products manufacturer get out of the basement so far as his mental attitude is concerned, if he is going to get out of the basement with his sales. He must learn to think in terms of 18 and 20 story building, not in terms of a basement or two. This development of big building stuff is only in its infancy yet and the manufacturer who does not see the handwriting on the wall has only himself to blame.

Merchandising

Merchandising was the theme of an address made by H. E. Shields of the Lehigh Portland Cement Company. He also stressed the fact that change was the keynote of modern business. And he proved it with a very interesting set of slides that showed change in aspects ranging from bathing suits to prize fights.

He spoke of the need for co-operative effort and demonstrated how others of the 78 industries actively engaged in co-operative advertising were struggling to get their ideas over to the man who spends the dollar. Somebody is going to get all or the most of that dollar and unless the products manufacturers definitely go out after their share, it will find its way into pockets that never were in the pants worn by products manufacturers.

Light-Weight Aggregates

E. W. Dienhart, known and admired by every one in the products industry, got up and told of the influence of light-weight aggregate in the products industry. Through the use of light-weight aggregate, the industry was able to gain a toe hold in the big building field. In concrete block made of light-weight aggregate, a building block was developed that overcame some of the objections to the older block and opened up a new field for the entire industry. It is in this new field that the greatest future developments in the industry can be expected.

And again came the warning that concrete block must be merchandised. In past years, the momentum of the large volume of building operations carried concrete block along with it in a large measure. Not so any longer. The block that goes out of the stock pile now must be sold! Now the competition is for your share of a pretty well stabilized volume of construction. To get it you've got to go out after it.

What Price Efficiency?

Plant layout was the subject of a paper read by C. S. DeLamater, sales director for the Consolidated Concrete Machinery Company. The subject was approached primarily from the standpoint of considering possible future needs when the plant is laid out. He who provides only for the needs of the immediate present when he lays out his products plant will pay for it in extra handling, etc., when the time comes that the plant must be expanded to meet an extended market.

The need of building up an adequate stock pile during the slow months was also stressed and dollars and cents figures were given to show that it is more economical to prepare for anticipated spring needs in the stock pile than to attempt to speed up production when the demand is upon you.

How We Merchandise

The last item on the official program was a series of short talks on the subject, "How We Merchandise Our Products." "Casey" Swanson, Austin Crabbs and J. A. Livingston of Toronto, Canada, contributed to this discussion.

The banquet—with entertainment furnished by the Consolidated Concrete Machinery Company—finished up the Tuesday session. What happened after the banquet nobody knows. But wasn't that ventriloquist good?

Iowa Association Institutes Testing Service

The tenth annual convention of the Iowa Concrete Products Association was held at the Savoy hotel, Des Moines, Iowa, on January 29th and 30th. A good deal of the interest centered around the discussions of the legislative outlook as it affects the Iowa products industry, and methods of arousing business conditions in the state from the lethargy of recent years.

Edward Kimball, secretary of the Iowa Manufacturers' Association, covered the legislative outlook in a lengthy discussion on the subject.

The latter part of the convention was devoted to a very animated discussion of the question of what the association could do for its members to further justify its existence. The suggestion that the Iowa group consider the question of merging with perhaps larger associations in adjoining states, met with a decided veto.

Following considerable discussion of matters that could be undertaken by the association, it was decided to adopt a definite program for 1929. The major activity, it was decided, will be the periodic testing of samples selected and sealed by local building officials and their testing by an accredited laboratory. The secretary will then write personal letters to architects, builders and others in the manufacturer's territory, explaining the high standing of the industry at the present time, and incidentally mentioning where products that meet the requirements of the Hoover building code may be secured locally.

The following were elected as the association's officers for the year: F. M. Popenhagen, president; Fred D. Reeves, vice-president, and R. L. Gavin, secretary-treasurer.

Purchasing Centrally Mixed Concrete

A User of Centrally Mixed Concrete Since 1925 Tells His Experiences in Meeting Questions of Effect of Hauling and Determining Allowable Time Between Mixing and Placing—Advises Establishment of Group of Requirements by Purchaser

By P. J. FREEMAN
Chief Engineer, Department of Public Works, Allegheny Co., Pittsburgh, Pa.

THE development of central mixing plants during the past few years has necessitated a revision of specifications as well as general ideas concerning mixing and handling concrete. In 1925 there were about 25 such plants and today there at at least 100 concerns making and selling ready mixed concrete.

One of the first questions encountered by the early purchasers of centrally mixed concrete was the effect of hauling and the determination of a maximum time allowable between mixing and placing the concrete.

The writer is indebted to Professor F. E. Gieseke for the information given in a paper before the American Society for Testing Materials in 1920 on the "Effect of Rodding Concrete." The method used by Professor Gieseke was to agitate fresh concrete by means of rods so that the air was removed and the time of final setting delayed. The test data showed that the strength of concrete was not injured by disturbing the initial set and that a very decided increase in strength could be obtained by agitating the concrete long after the degree of hardening known as the initial set had taken place.

When the writer was first called upon to approve the use of about 28,000 cubic yards of centrally mixed concrete for the land piers of the Liberty bridge, being built by Allegheny County in 1925, there were no data at hand to show the effect of hauling concrete and no time to make such tests. The decision to use ready mixed concrete was based largely upon the conclusions of Professor Gieseke for the writer believes that they apply equally well to properly proportioned concrete which is being hauled as to the methods used by Professor Gieseke in his laboratory.

Conditions Influencing Use of Ready Mixed Concrete

The piers were to be built in the Baltimore and Ohio Railroad yards and there was scant room for operating ordinary mixing plants in winter weather. The fact that all materials could be easily heated at the central plant and accurately proportioned, led us to give serious consideration to the first request to use centrally mixed concrete.

The length of the haul was about 2½ miles and the standard specifications required all concrete to be placed inside of 45 minutes after mixing. The practice of having our plant inspectors give a ticket to the truck driver to be delivered to the inspector at the job was started. This practice is still continued and although the time limit of 45 minutes may not be necessary, conditions are such that it is not necessary to exceed this time. The tickets are in duplicate and carry the particular job number, proportions used, amount of water, date and exact time of emptying mixture into the truck, stamped by a time clock.

Permission to use centrally mixed concrete was therefore granted with the further stipulation that cubic yard buckets being used have drop-bottoms so that the concrete could be readily placed in the forms without additional handling. It required only a short time to enter the railroad yard and lift the buckets from the trucks with a hoist and deposit the concrete in the forms, and the process did not in any way interfere with the railroad.

Tests were made on 6 by 12 inch compression specimens at the mixing plant and at the piers but no falling off in strength was encountered and the practice of making specimens at the mixing plant was adopted on account of the greater convenience for curing in cold weather.

Similar tests have been made at various times on other jobs but nothing has been found to indicate the lowering of concrete strength due to hauling. If the concrete is not segregated when it arrives at its destination, the quality is not impaired.

The results of tests given in "Public Roads," September, 1928, indicate that the quality of concrete is not injured by hauls up to 25 miles in distance or three hours duration provided the material is delivered in a workable condition and will not need additional water to facilitate its handling.

After the very satisfactory experience with the land piers of the Liberty bridge, centrally mixed concrete was used for various purposes in Allegheny County. The most spectacular structure was a concrete slope wall 90 feet high which required approximately 10,000 cubic yards of concrete. The mix was 1:2:4 gravel concrete and the material was handled in cubic yard buckets and placed with a crane. The length of haul was about two miles. The materials were workable when they arrived on the job and it was possible to place the concrete in a rather narrow section without an undue amount of honeycombing. The exposed surface of the slope wall is approximately 30,000 square feet and it was not necessary to retouch more than twenty square feet of the entire surface.

Concrete for the base course of a small bridge floor was hauled to a suburb of Pittsburgh, a distance of approximately 9 miles with only partial success. The mix and materials were the same as for the slope wall but the concrete was hauled in ordinary dump trucks. The first few truck loads in the morning would arrive in a very satisfactory condition on account of the fact that they were not delayed by traffic. Later in the morning when traffic began to delay the trucks the long haul over very rough streets produced a segregated concrete which was not satisfactory. It was necessary to re-mix the concrete with shovels before it could be placed but the addition of water was not permitted.

These three instances represent typical conditions which

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have been encountered with centrally mixed concrete involving the placing of more than 50,000 cubic yards. Our contracts are with a general contractor who is responsible to the county for all sub-contractors including a central mixing company and the mixing and placing of concrete must comply with the printed standards of construction whether the concrete is made on the job or at a central plant. These specifications cover all details from the filing of a bond to the final acceptance of the structure.

The use of centrally mixed concrete for any particular job is therefore subject to the approval of the engineers of the Department of Public Works before the job can start.

Supplementary Mixers on Large Jobs

The central mixing plant equipment may be better than that which is available in the field and for that reason we like to use concrete from a central mixing plant whenever it is possible. If the area of a pier is so great that it requires a large amount of concrete per hour to keep from disturbing that which was partially set, it may be necessary to require the general contractor to furnish one or more concrete mixers to supply concrete in addition to that coming from a central mixing plant.

These details must be agreed upon before the general contractors receive permission to use concrete from a central mixing plant. With the increased capacity which the larger units are developing and the improvements in methods of hauling and placing concrete, it may be possible for us to remove some of these restrictions in the future.

If the concrete is to be purchased directly from the central mixing company then there are a number of considerations which must be taken into account that do not concern a municipality which is having work done by a general contractor under standard specifications. It is the duty of the engineer responsible for the work to see that his purchase orders for specifications are so drawn that the interests of the owner in whose structure the concrete is being used, are properly safeguarded.

The size and nature of the work will, of course, govern the extent of these requirements. A few general suggestions will be given which should be considered in preparing such a purchase order for centrally mixed concrete to be used in a rather important construction project. More items can be added for larger work and some of these eliminated for lesser structures.

(a) Investigate all mixing plants available and note the general nature of the equipment and methods of operation. Inspect the measuring devices and observe the quality of materials available.

(b) If the proportioning devices permit the weighing of all cement, sand and coarse aggregate, the basic mix (preferably determined in advance from tests) should be stated giving definite weights for each material from a given source.

If the water-cement ratio is to be used for proportioning the desired limits should be placed on the water and also on the aggregates.

(c) State the minimum time of mixing which will be permitted.

(d) Fix the minimum temperature at which concrete shall be delivered on the job (70 deg. F.).

(e) State unit price for addition or deduction of cement, sand or coarse aggregate. Make provision for changing the mix if it is found desirable.

(f) Establish unit price for the addition of any desired admixture.

(g) State definite basis of payment for mixed concrete delivered on the job. If all materials are weighed, it is preferable to base this price on the actual weight of mixed concrete delivered, rather than on a cubic yard basis.

(h) Provide for the engineer's inspection at the central mixing plant and for tickets to accompany each delivery truck.

(i) Provide for reasonably uniform delivery of so many yards per hour (60 yards per hour for an ordinary job is a good rate) depending on the size of the job, number of hoists or other equipment used to handle the concrete when it arrives. Have an understanding as to the type of truck which will be used for hauling the concrete. In some cases it may be necessary to require special equipment or trucks to handle the concrete when it arrives on the job. Some central mixing plants can furnish rotating drums or various types of trucks which will agitate the concrete for long hauls.

(j) Provide for testing a definite number of concrete specimens by a laboratory to be selected by the engineer, but at the expense of the central mixing company. The number of specimens should be governed by the quantity of concrete placed or in some way which cannot be misunderstood. This feature frequently causes ill-feeling because the central mixing company may feel that the engineer is selecting more specimens than the price given warrants and a definite understanding should be had before the work starts.

(k) Provide for cutting off delivery and disposal (to other work) of concrete en route in case of accidents on the job or for a hold-up in construction.

(1) Make provisions for cancellation of the contract in case the engineer finds cause for doing so. Provide for rejection of loads received in bad condition on account of segregation, excessive water or extreme delay in delivery. In such cases that the work is handicapped by the failure of the central mixing company to make delivery according to the arrangement, provision should be made to reimburse the owner or general contractor for the expense of installing his own mixing plant.

(m) Have a definite understanding regarding charges for delivery before or after regular working hours or on Saturday afternoon and Sundays. There should either be no charge or a fixed sum for such overtime work.

(n) Arrange for guarantee against labor trouble in case the mixing plant uses non-labor in a closed district.

(o) Provide for surety bond if the volume of work warrants.

Northwest Products Men Meet at Oregon

In spite of an attendance somewhat below par due to bad weather, the fourth annual meeting of the Northwest Concrete Products Association was successful if measured in terms of experiences and data interchanged. The gathering was held at Eugene, Oregon, on January 25th and 26th.

Some of the high spots of the program are these: H. P. Davidson, of the Oregon Cement Co., told of the work of the Pacific Northwest Advisory Board, H. S. Rogers, director of engineering, experiment station, Oregon State College, talked on "The Modern Spirit of Industry," and S. H. Graf, director of engineering research, Oregon State College, talked on "Fundamental Principles of Grading Aggregate as Applied to Dry Mixes." "Rock Formations from Which Cement Is Made," was the subject of a talk by Dr. E. L. Packard, of the geology department, University of Oregon.

BUTLER CENTRAL MIXING PLANTS

ECONOMY — and profits; these are the two big factors in central mixing plant operation.

Economy for the contractor because he can discard mixing equipment and the expense of repairs, operation and maintenance.

Profits for the operator because he can furnish a better product at a lower cost than it can be mixed on the job.

With a Butler Central Mixing Plant controls are so located as to enable one man to weigh off sand, stone and cement and also operate water and mixer discharge.

Ask our nearest representative.

BUTLER BIN COMPANY
Waukesha, Wisconsin
Representatives in fifty principal cities.

BUTLER
Steel **BINS**

Index to Advertisements on Page 5

About Makers of Equipment and Materials

NOTES FROM THE FIELD

DeVilbiss Company Reorganized

The reorganization of the *DeVilbiss Company*, of Toledo, Ohio, following the death of the founder and president, Thomas A. DeVilbiss, finds *Allen D. Gutchess*, a nephew of Mr. DeVilbiss, in charge of the immense industry which during the lifetime of Thomas A. DeVilbiss grew from an obscure operation to an institution represented in all the markets of the world, and supplying spray painting and finishing systems to all civilized countries.

Mr. Gutchess began work for his uncle at the age of 14 years, and is now but 35.

Other new officers are William M. Booker, chairman of the board; Frank A. Bailey, vice-president and general manager; William F. Gradolph, general sales manager; Frank C. Penoyar, secretary; Walter W. Conklin, treasurer; and Howard DeVilbiss, son of the founder, assistant secretary.

Columbia Chemical Products

Sales of all special products manufactured by the *Columbia chemical division, Pittsburgh Plate Glass Company*, are now being handled direct from Barberton, Ohio, where the plant is located, instead of through outside agencies as in the past.

The first step in putting sales under factory control at Barberton occurred a year ago when the company started marketing its "3-C" brand calcium chloride direct.

Now there has been formed the Columbia Products Company as the selling organization for calcium chloride, plant lime, whiting, salt and Hennig purifier. Officers of the Columbia Products Company are all executives of the Columbia Chemical Division. The new arrangement offers the advantage of more direct relationship with customers and also the services of the up-to-date laboratories and research departments at Barberton.

Barber-Greene Branch Offices

Barber-Greene Company, Aurora, Illinois, manufacturers of ditchers, loaders, etc., have recently opened a new office in Cedar Rapids, Iowa, at 527-528 Merchants National Bank Building. This office is under the supervision of *Jack Marson* of the Barber-Greene Company. Mr. Marson has been with the Barber-Greene Company a number of years.

W. E. Toole opened at the same time a branch office under Marson at 1106 Nicholas Street, Omaha, Nebraska.

Trainor McEverlast Manager

Lee S. Trainor has been appointed district manager of its newly established Chicago office at 35 East Wacker drive by *McEverlast, Inc.* This firm is the patentee of the Hunt process of curing concrete and other protective coatings.

Mr. Trainor was until recently the manager of the Highways and Municipal bureau of the Portland Cement Association.

Smith Buys Kwik-Mix

The T. L. Smith Company of Milwaukee announces the purchase of the *Kwik-Mix Concrete Mixer Company*, Port Washington, Wisconsin. The entire plant of the company at Port Washington will continue to be operated as heretofore with the exception of the business office, which will be combined with the T. L. Smith Company Milwaukee office.

With the acquisition of the various Kwik-Mix models, the T. L. Smith Company now has one of the most complete lines of mixers ranging from the 2½-S size to the 112-S tilter, said to be the world's largest mixer.

The T. L. Smith Company is one of the independent divisions of the *National Equipment Corporation.*

New Laboratory at Detroit

To increase its facilities and render improved service, the *Forest City Testing Laboratory Company*, at Cleveland, Ohio, will open shortly a branch office and laboratory in the Campau Building, at 429 Griswold Street, Detroit, Michigan.

Harold Watson Bates, vice-president, will be in charge of this office.

New Lockstrip Manufacturer

With the beginning of the new year, the *Locksmith Manufacturing Corporation* of Long Island City, N. Y., took over the manufacture and sale of the product of the Lockstrip department of the Traitel Marble Company, Long Island City. The "T.M.C." lockstrips, as they are known, are brass or other metal strips used in the laying of terrazzo, cements, and composition floors to form ornamental outlines and expansion joints. It has horizontal flanges to prevent settlement and lifting and perforation to allow the continuity of bond.

The Lockstrip Corporation has also begun the manufacture of a strip which is inserted in the floor finish coat to form a flush joint for expansion and for ornamental purposes.

INDUSTRIAL LITERATURE

Oxy-Acetylene Report

The International Acetylene Association, with head offices in New York City, has compiled into a booklet of 106 pages a report of the meeting of the Oxy-Acetylene Committee of its organization held during November. The report constitutes a survey of the uses of the oxy-acetylene welding and cutting process.

Typical sections are devoted to welding materials, testing welders, procedure control, highway construction, and pipe lines.

Silicate of Soda for Curing

One of the several available curing coatings is R-B Silicate of Soda, produced by the *Grasselli Chemical Company*, Cleveland, Ohio. This method and product are described comprehensively, regarding manufacture, application, equipment, efficiency, and advantages in a 26-page publication newly completed.

Ceilings Vs. Aisles

A new piece of descriptive literature on an overhead conveying system has just been received from the *Louden Machinery Company*, Fairfield, Iowa. Following its theme of "Keep the Aisles Clear by Using the Ceilings," it describes briefly the new Super-Track equipment for heavy duty being produced by the firm.

Pavement Construction System

A 12-page booklet entitled *"What is 'Armorplated' Compressed Concrete"* outlines the methods and equipment used in this system of pavement construction. Photographs show details at various stages.

This is one of the publications of the American Vibrolithic Corp., Des Moines, Iowa.

Incor Publication

"Not a Working Hour Lost Thanks to 'Incor,'" is the title of another of the *International Cement Corporation's* 4-page folders presenting facts and specific projects where its new high early strength portland cement, Incor, has been used.